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THE

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The National Rose Society's Handbook on the Insect and Fungus Pests of the Rose

ENTITLED—

THE ENEMIES OF THE ROSE

NEW EDITION

BY

FRED. V. THEOBALD, M.A. (Cantab.), F.E.S., Hon. F.R.H.S., Etc.,

AND

JOHN RAMSBOTTOM, O.B.E., M.A., Sec. L.S.

With coloured plates by
MISS FRANCES BUNYARD, A.C.T.C.

Edited by the Hon. Secretary, under the direction of the Publications Committee.

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PREFACE.

THIS useful work, which has been most carefully revised and additions made to it by Mr. F. V. THEOBALD and Mr. JOHN RAMSBOTTOM, gives the life history of some of the different insect and fungus pests which attack the Rose, together with instructions as to how they may be kept in check, and destroyed.

The excellent illustrations by Miss BUNYARD will help the identification of the chief insect enemies, while the coloured reproductions from photographs will be a ready means of identifying the principal diseases caused by fungi with which Roses may be attacked.

Beginners, and those having little knowledge of Rose-growing, will in the first instance do well to consult the Introduction, in which an endeavour has been made to show how comparatively easy it is to keep in subjection the most common enemies the Rose grower has to contend with.

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Page 28 (Plate V., Fig. 1) should read (Plate I., Fig. 1.)

INTRODUCTION.

THE inexperienced Rose lover need not be alarmed at the large list of enemies described in the following pages, for after all only in exceptional cases is he likely to be seriously troubled by any but the following :—

1. **Caterpillars.**—With the advent of the new leaves on his Rose plants in the spring will come all sorts of caterpillars ready to destroy the buds and foliage. These must be sought for on their first appearance, and wherever a leaf is found curled up it must be picked off, and the grub or caterpillar concealed in it crushed between the finger and thumb while still young. But it is far better to kill them before the leaves curl up by spraying and so prevent the damage.

2. **Rose Aphides.**—Those green or reddish little creatures called Plant Lice may be seen on the leaves, shoots and roots of Roses, and more particularly at the tips of the shoots and leaves, at almost any season of the year. If taken in time, that is when they are few in number, they can be kept in check by the frequent and skilful use of the spraying machine, or they may rapidly multiply. The plants may be sprayed with

any one of the insecticides mentioned here. Care must, however, be taken that the preparation is never applied stronger than stated in the directions supplied.

3. **Mildew.**—This will be found to be one of the worst of the enemies of the Rose here dealt with, and the most difficult to overcome. It appears as a white mould on the foliage of Rose plants, and if not promptly checked will spread from one plant to another over the whole collection. There are few, if any, gardens entirely free from this disease, although in some it is much more troublesome and persistent than in others, and more particularly in the autumn. By those who may not have the means of spraying the plants with the preparations mentioned on page 134, it may be kept in check with flowers of sulphur, black sulphur for preference. The simplest way to apply this remedy is to lightly dust the sulphur over the whole of the affected plants, by means of a fine muslin bag, on the first calm evening after it is detected, and to repeat the dusting at intervals as may be found necessary until the mildew has disappeared.

There are two golden rules which should be kept in mind when waging war against the above insect and fungus pests. The first is to look out for them early and on their first appearance to at once take the necessary means for their destruction. The second is to persevere with the remedy adopted until a cure has been effected.

It should not, however, be long before the tyro in Rose Culture will be in a position to appreciate and take advantage of the more scientific methods described in the following pages for the prevention and destruction of the foregoing and other pests that the Rose is heir to. But, as regards the insect pests of Roses, Mr. Theobald truly says, " the remedies which one need apply are few and simple. They may be summed up as ' just a little gentle washing with non-caustic substances, and a lot of finger and thumb work.' "

NOTE.—Members who find any difficulty in carrying out the directions given in this little manual, or who meet with any insect or other pest attacking their Roses, which they are unable to distinguish, and are consequently at a loss to know how to deal with, are invited to apply to the writers on the Rose Enemies. They must be sent direct and in a tin box or may be crushed in transit. If sent, unless direct, they may be too old and dried to name.

INSECT ENEMIES.

By Fred V. Theobald, M.A., F.E.S.,
Hon. F.R.H.S., etc.

GENERAL REMARKS.

There are so many insects which the Rose grower finds on his plants that it is quite impossible to refer to them all in this small manual. Some of the worst kinds only which have been complained of or observed as being harmful are dealt with. Probably these constitute the majority of insects, which we may term "pests."

One readily notices a few leaves or buds of a Rose being eaten by a caterpillar, or a few plant lice or leaf hoppers, whereas in most other vegetation one pays no attention to such insects unless they are very numerous and are causing serious loss. The reason is that Roses are really very tender plants and a few insects present may cause disfigurement or serious harm.

The remedies which one can apply for the insect pests of Roses are few and simple. They may be summed up as "just a little gentle washing with non-caustic substances and just a lot of finger and thumb work." With regard to the last method I do not

mean crushing the insects in and on the leaves, but carefully picking them off.

One point we may draw attention to, and that is that we must be careful not to introduce pests into our gardens on new plants or on briars. We must also keep a sharp look out for young insects, and try and get rid of them before they do any damage, and also check the first signs of aphid attack.

Late autumnal attacks of insects are often disregarded, but we should bear in mind that the leaves are essential until the wood has ripened, and it may often be necessary to cope with such pests as the leaf-eating sawflies, leaf hoppers, and some caterpillars in the autumn.

Recent researches have shown that nicotine wash is by far the best general wash for Roses, and does not harm or disfigure the foliage or even blossoms. If such insects as the caterpillars or grubs of the Tortrices which spin up leaves are crushed with the fingers on Roses the bushes must be well syringed with water after, as the damaged insects stain the leaves and set up decay. If the Roses are sprayed with nicotine early, this crushing is not necessary.

GENERAL ACCOUNT OF INSECTS.

Insects belong to a group of animals called Arthropoda—jointed-limbed animals.

These jointed-limbed animals are very varied in structure, habits, and development.

Amongst this group of diverse forms we find such as the Crabs, Lobsters, Shrimps, Woodlice, Spiders, Ticks, Red Spiders, Harvest Bugs, Centipedes, Millipedes, and the true Insects or Hexapods.

All this assemblage of forms can be told from other animals by their segmented bodies, accompanied by two or more pairs of jointed limbs and other jointed structures attached to the head. As this little manual deals mainly with the true Insect Enemies of the Rose, it is necessary to point out what are the differences between true insects and the other jointed-limbed animals. These creatures are divided by Zoologists into four groups known as Crustacea, Arachnoidea, Myriapoda, and Hexapoda.

Briefly they may be told by the following characters :—

A.—Crustacea (*Crabs, Lobsters, Woodlice, Etc.*). Mainly aquatic. The body is roughly divided

into two regions, the so-called cephalo-thorax (head and thorax) and abdomen. There are organs of locomotion attached to the lower side of *most* of the segments of the body, and they breathe by means of gills, attached to the legs. The Woodlice are the only ones that do any harm to plants, but I have never known them to attack Roses.

B.—Myriapoda (*Centipedes and Millipedes*). These animals have their head distinct and the rest of the body is divided into a series of rings ; they have always organs of locomotion (legs) on all the segments when adult. In the beneficial Centipedes, one pair to each segment ; in the injurious Millipedes, two pairs to all the segments except the first three, which have but a single pair. None have been recorded attacking Roses.

C.—Arachnoidea (*Spiders, Mites, Etc.*) These have the head and thorax united (Spiders) or the head distinct from the more or less fused thorax and abdomen (Ticks and Red Spiders). They have *four pairs* of legs attached to the lower surface of the thorax when adults, except the Gall Mites (Eriophyes), such as the Big Bud Mite of Currants, in which there are only *two* pairs. In the young stages many, such as the Red Spiders, have three pairs of legs.

D.—HEXAPODA (*True Insects*). These have *six* legs attached to the thorax when adult—never *eight*, and none on the abdomen. They breathe by means of air tubes or trachea.

Most of the creatures dealt with in this book are six-legged or *hexapod* animals, which are properly called insects. The Red Spider belongs to the Arachnoidea.

STRUCTURE OF A TYPICAL INSECT.

The Grasshopper will serve as the best example to study the structure of a typical insect. We can at once see that the body or trunk is divided into three portions called (1) head, (2) thorax, (3) abdomen. The head bears the following structures—two antennæ, two or more eyes and the mouth.

The *mouth* is composed of six pieces, namely, a pair of hard horny biting jaws called mandibles ; a pair of soft jaws below called maxillæ or chewing jaws ; a plate above, the upper lip ; a platform below (really double), the lower lip. The maxillæ and lower lip each bear a jointed process on their sides, the maxillary and labial palpi respectively. These palpi are sensory organs. The *eyes* are of two kinds, compound and simple. The former are large and are placed on each side of the head ; they are composed of a number of hexagonal columns or facets ; the surface of the eye resembling a piece of honeycomb.

The simple eyes may be absent or they may be two or three in number, situated on the summit of the head ; they are seen as small raised points, easily noticeable in bees.

The *feelers* or *antennæ* are jointed processes of great diversity of form ; they may be thread-like or plumose, pectinated or elbowed, etc. The antennæ often differ in form in the two sexes. They are sensory organs, being connected with the senses of smell and touch and possibly hearing.

The *thorax* or mid-body is normally composed of three rings or segments, called the pro-, meso-, and meta-thorax. These parts may be quite separate as seen in a grasshopper, or more or less fused as seen in a bee.

The thorax carries the organs of locomotion, namely, wings and legs. The former are attached to the upper part of the thorax and may be of one or two pairs, or they may be absent (=*apterous insects*) ; the first pair of wings are attached to the mid-portion of the thorax. In some insects, such as the female Winter Moths, the wings although present are very much reduced and are useless as organs of flight. An insect wing normally is a thin membranous expansion, supported by rigid hollow ribs, called veins or nervures, which contain air tubes, etc. The neuration of the wings is important in identifying many

insects. The wings are frequently much modified, for instance in a Beetle the front pair are hard, horny structures (=*elytra*) ; in Butterflies and Moths they are usually covered with scales.

The *legs* when present are attached to the lower part of the thorax ; they are either six or absent (=*apodal insects*). Each pair is united to a thoracic ring, the first are called pro-thoracic, the second meso-thoracic, and the hind pair meta-thoracic legs. The legs are jointed and are normally made up of nine segments ; the basal one is the coxa ; this is followed by a small segment, the trochanter, then the long femur, and the tibia or shank, lastly the foot or tarsus, which is composed of from one to five segments. The last tarsal segment ends in two claws or ungues, which have between them differently shaped structures called pulvilli or pads, etc. There is much modification in insect legs ; some are long and thin and adapted for running (Tiger Beetles), others have them broadened and adapted to scraping in the soil (Mole Cricket), others for jumping (Grasshoppers and Locusts), yet others for swimming (Water-boatmen). The abdomen is composed of a varied number of rings or segments—each segment having an upper and lower moiety, united by a soft membrane, thus enabling the expansion of the abdomen ; there are soft areas also between the segments. No traces of organs of locomotion can be found on the abdomen, but it terminates in varied

structures, such as a long egg-tube or ovipositor in some females (Ichneumon Flies), a sting (Bees and Wasps), or in the males in distinct clasper-like external sexual appendages. At the sides of the abdomen and thorax we find a series of slit-like openings ; these are called *spiracles or breathing pores.*

RESPIRATION OF INSECTS.

The spiracles are the breathing pores of the insect. Unlike the higher animals insects do not breathe through their mouth, nor have they lungs, nor is the blood carried to the air to be oxygenated. Insects respire by means of a series of fine tubes called *trachea,* which run all over the body and carry air to the various parts. The trachea are cylindrical tubes and branch into smaller and smaller divisions ; they are thin-walled, but are supported by a spiral band. When an insect is opened and placed under water, these tubes look like silvery streaks, owing to the air they contain. The spiracles are openings of definite form and position at the sides of the abdomen and two pairs also on the chest, from which the main trunks of the air tubes arise. Each spiracle is kept open by a hard rim around the edge, and from this, fine, hard processes pass across the opening. Thus dust, etc., is stopped from entering the air tubes. It is these spiracles which we can close up by some sticky substance adhering to them and so kill such insects as Green Fly or Plant Lice. A few insects, however, breathe by gill-like structures (May-fly

larvæ), and others have part of the intestine modified (Dragon-fly larvæ) for respiration, but such do not need our attention here. Mites such as the Red Spiders do not, however, breathe in this manner, but through the skin.

THE GROWTH AND DEVELOPMENT OF INSECTS.

There is still lingering a popular idea that a small fly will grow into a large fly, a small bee into a large one. This is never the case. Insects in developing pass through a series of changes, spoken of as the transformation of insects or metamorphosis. These, often complicated, changes take place during and after a period of growth. The phases in the life of a typical insect are, first the egg stage, second the larva or caterpillar, third the pupa or chrysalis, and fourth the sexual adult. The changes in the egg, so-called embryonic changes, need not concern us. The larval stage is the period of growth, the period of ravenous feeding, the time during which the majority of insect enemies of the Rose are so harmful. The caterpillar on leaving the egg shell is very small. It gradually grows until its skin is too small to contain the body contents. The skin then splits and the insect crawls forth from the old skin with a new one ready formed beneath, soft in texture and capable of expanding. This process of casting the skin is known as " Ecdysis." Several of these moults take place in the larval stage. Preceding, during, and just after the moult, the larva does not feed, and moreover

is sluggish and tender. At this time it is often more easily killed by contact insecticides than at others (=freshly moulted green fly and leaf-hoppers and even caterpillars).

At last the larva reaches maturity and then casts its skin for the last time and enters the third phase of life, the pupa or chrysalis. Previous to so doing, the larva either spins a cocoon of silk or attaches itself at its tail end to some object by silk, or enters the soil and forms a case of earth in which the pupal stage is found ; a few pupæ are found nude in the soil, others in wood and seed.

This *pupal stage* is the period of metamorphosis or transformation. The pupa proper is incapable of any great movement, nor does it take food. It is the period when the greater part of the caterpillar's organisation is destroyed and remodelled into the adult. This is when we have complete metamorphosis as seen in the Butterfly, but when the metamorphosis is incomplete the so called pupa keeps active and feeds.

Pupæ may be found in all manner of places, some in cocoons, others naked in the soil, in tunnels, in wood, etc., and they vary greatly in shape and slightly in colour. During this stage the different parts of the mature insects are formed, and these are seen marked out on the pupal shell. Some insects (Cecids or Gall Midges, etc.) pupate in the old larval skin, which

forms what is called a *puparium*. Some aquatic pupæ, such as in the mosquitoes, are active, but still take no food.

COMPLETE AND INCOMPLETE METAMORPHOSIS.

Insects as the Rose Tortrix Moths undergo what is called complete metamorphosis, others such as the Rose Aphides an incomplete metamorphosis. Complete metamorphosis is where there are the following stages :—(1) an egg ; (2) an active feeding, growing creature, the larva or caterpillar ; (3) a quiescent, non-feeding, practically non-active pupa ; and (4) the active, sexually perfect adult. Such we find in bees, flies, beetles, moths and butterflies.

Insects which undergo *incomplete metamorphosis* are those which have no *true* pupal stage. There is the egg (1), then (2) the active growing larva, followed by (3) the *active* pupal stage—the nymph, which feeds and moves just as the larva or adult does ; finally (4) we have the sexual adult. The nymph stages are very like the larva, except that wing-buds appear at the sides of the thorax and develop gradually.

There are insects with no metamorphosis at all (*Aptera*), but none of these are known to do any harm to Roses.

BITING AND SUCKING-MOUTHED INSECTS.

Hexapods have two main types of mouth, namely, the biting mouth and the sucking mouth. The former

are called " mandibulate," the latter " haustellate " insects. The biting-mouthed insects, such as the beetle, have hard, horny, biting jaws, and gnaw their food. The sucking-mouthed insects have (*a*) sharp piercing mouths, such as aphides and bugs, or (*b*) non-piercing but sucking mouths, such as the butterfly or the house fly. The first (*a*) live on the sap of plants and the blood of animals and man. The second (*b*) on the *external* juices of plants and animals. The mandibulate insects we can kill by covering the foliage with poison ; this would not affect the haustellate insects. The latter we have to kill by either blocking up their breathing pores, or by corroding their skin, or by applying poisons such as nicotine, which penetrates into them and paralyses them. Frequently insects are too powerful for these processes to affect them. Then we must fall back on methods of trapping. The leaf and blossom caterpillars are instances of biting-mouthed insects attacking the Rose. The Aphides and Scale Insects and Leaf-hoppers are instances of piercing-mouthed Rose pests.

ORDERS OF INSECTS.

Insects are divided into groups, called Orders. Each order is further divided into sub-orders, and families, and each family is composed of one or more smaller groups called genera, each genus being composed of one or more species. For practical purposes we may divide the Hexapoda into the following Orders :—

A.—Metamorphosis Complete.

Order I.—COLEOPTERA (Shield-Winged Insects). These are beetles. They have two pairs of wings. The first pair are hard and horny (*elytra*), folding over the body ; the second pair are membranous and are folded up under the elytra. Mandibulate.

Order II. — LEPIDOPTERA (Scaly-winged Insects). Butterflies and moths. The four-broad membranous wings more or less covered with scales. The butterflies (*Rhopalocera*) with club-like feelers, the moths (*Heterocera*) with feathery, thread-like or pectinated antennæ. Haustellate when adult ; mandibulate when larvæ.

Order III.—HYMENOPTERA (Membranous-winged Insects). Ants, bees, wasps, sawflies, ichneumon flies, &c. Four membranous transparent nude wings with comparatively few veins. Mouth partly mandibulate, partly haustellate.

Order IV.—DIPTERA (Two-winged Insects). Flies. Two wings only ; the second pair reduced to two small club-shaped processes called balancers. Haustellate when adult ; Mandibulate, or partially so when in larval stage.

B.—Metamorphosis Incomplete.

Order V.—HEMIPTERA (Half-winged insects). Plant lice, bugs, leaf hoppers, scale insects, &c. Four

wings ; front pair either with basal area horny or leathery (Heteroptera or bugs) or transparent and uniform (Homoptera or plant lice). Mouth formed into a piercing proboscis, which in the scale insects may be very long.

Order VI.—ORTHOPTERA (Straight-winged Insects). Grass-hoppers, crickets, etc. Four wings, the first pair rather narrow, with more or less straight veins, the hind pair large and fan-shaped. Mandibulate.

Order VII. — NEUROPTERA (Lace-winged Insects). Dragon flies, lace-wing flies, &c. Four more or less uniform wings with a dense network of veins. Mouth mandibulate.

Order VIII.—THYSANOPTERA (Thrips). Insects of small size, with four narrow fringed wings and weak suctorial mouth.

Order IX.—EUPLEXOPTERA (Earwigs). The front pair of wings small and leathery, the hind pair large and fan-shaped and folded up under the small elytra. Anal claspers.

C.—No Metamorphosis.

Order X.—APTERA (Wingless Insects). Spring-tails and Silver Fish. No wings.

Of these the chief orders found affecting Roses are the Coleoptera, Lepidoptera, Hymenoptera, Diptera, Hemiptera and Thysanoptera.

BEETLES *(Coleoptera)* INJURIOUS TO ROSES.

Four kinds of beetles only have been complained of as enemies to Roses in this country, namely, the Rose Beetles, the Chafers, the Weevils of several species and the Raspberry Beetle.

THE ROSE BEETLE *(Cetonia aurata)*.

This beautiful beetle is frequently found in the blossoms, and when present in numbers does a good deal of harm. Its distribution is very wide in Great Britain, but it becomes rarer as we proceed northward. The beetles are also called Green Rose Chafers. They are harmful to many other plants besides Roses. Damage is done by both adults and the grubs or larvæ. The former eat the petals of Roses and the foliage, the latter the delicate and even thick roots. The brilliant shiny coppery green beetles may have a few pale creamy marks on the wing cases (Plate V., Fig. 1). They fly readily in bright sunshine, but in dull, damp and cold weather they are very sluggish and are then found nestling in the Rose blossoms. The anthers of flowers are mostly attacked, but also the petals and even the Rose leaves.

LIFE HISTORY AND HABITS.

The beetles appear in the middle of May and continue on through June. They deposit their eggs in the ground, especially choosing rich, light soil. The eggs hatch into white grubs, swollen at the end, with large brown head and six legs on the first three rings of the body, and are very like the grubs of the Cockchafers, but they have longer legs and a deep reddish-brown spot on each side of the first thoracic segment. The food consists of the roots of various plants besides the Rose. When mature their length is about an inch and a half. The full fed state is reached after two or three years in the soil. They then change to pupæ in earthen cells, about an inch long, smooth inside, rough outside. The pupæ are usually found deep in the ground.

The larvæ eat right away at the rootlets and gnaw the skin off the larger roots.

The same treatment is necessary as for Cockchafers (see page 32).

THE COCKCHAFER *(Melolontha vulgaris)*.

The Cockchafer, also called the " May-bug," is sometimes harmful to Roses. The adult devours the foliage and sometimes the blossoms, and their grubs the roots. These chafer-grubs are frequently spoken of as " White-grubs " (Plate I., Fig. 2a).

This beetle is common over a large part of Great Britain, but a closely-allied species (*Melolontha hippocastani*) takes its place in the North. As everyone knows these chafers appear in large numbers in certain years. This is because they take some time to develop in the grub state in the ground. The presence of these white-grubs at the roots of Roses is very deleterious, and they very soon kill the tender kinds ; we have known both hardy Moss Roses and tender varieties killed by them.

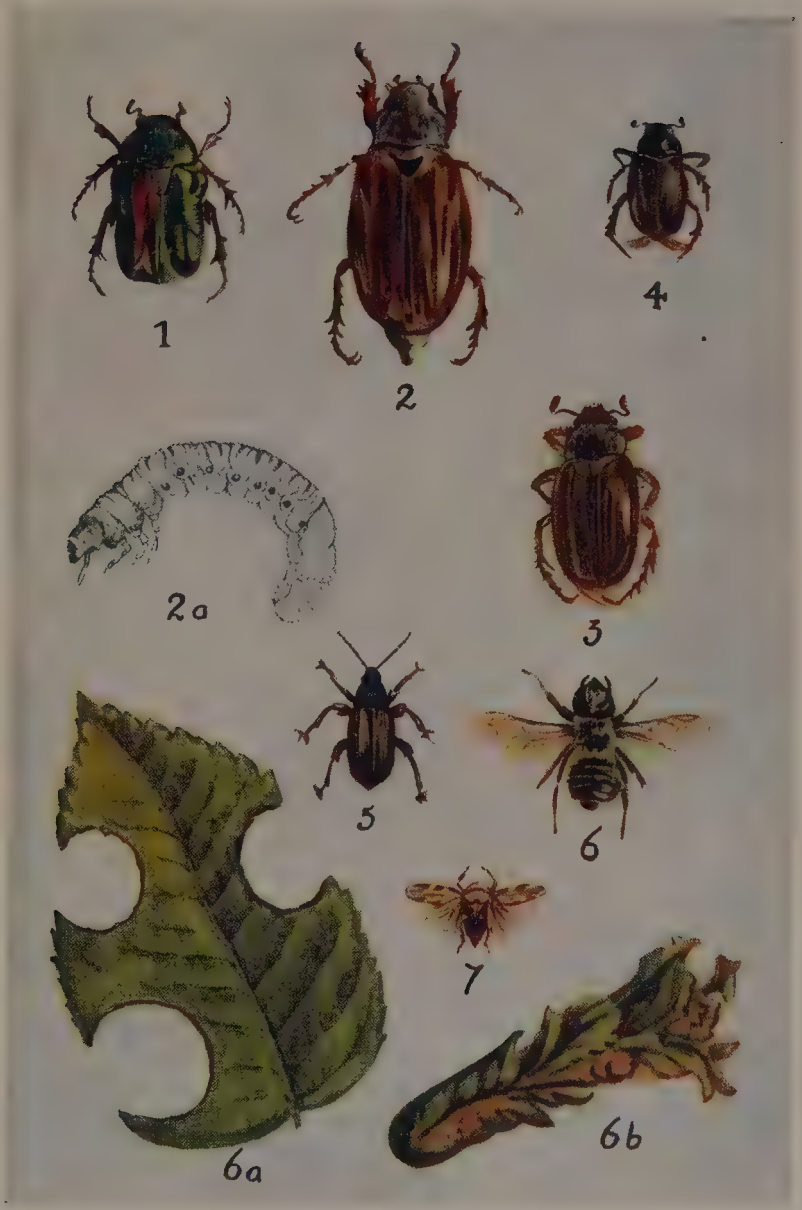
The beetle is about one inch in length, its head and thorax black, its wing-cases reddish-brown and hairy, each with four raised lines, and when freshly hatched covered with a greyish dust, and at the sides of the abdomen are prominent black and white marks (Plate I., Fig. 2).

These chafers belong to what are called Lamellicorn beetles, because the ends of the feelers are composed of several leaf-like plates or lamellæ.

LIFE HISTORY AND HABITS.

The beetle appears in May and June and flies in the evening. The female lays her eggs in the ground, choosing dry soil. The ova are creamy white and about the size of a hemp seed. The grubs are creamy white, thick and fleshy, the tail end being swollen into a semi-transparent bladder-like sac ; the head is large and horny with strong jaws, and there are six jointed

Plate I.



1, The Rose Beetle. 2, Cockchafer. 2a, Larva 3, Garden Chafer. 4, Summer Chafer. 5, Leaf Weevil (*Phyllobius oblongus*), twice natural size. 6, Leaf Cutting Bee or Megachile. 6a, Damaged Leaf 6b, Leaf-Nest. 7, Rose Frog Fly or Cuckoo Spit Insect (wings expanded).

legs in front. They lie in a curved position and when mature reach 1½ inches in length. Three years are passed in the soil before they become mature. When full grown they burrow deep into the earth and form an oval chamber in which they change to the pupal condition. The beetles hatch out some little time before they escape from the soil. Thus we get these chafers appearing every fourth year.

The Summer Chafer *(Rhizotrogus solstitialis).*

The Small or Summer Chafer also attacks Roses. It is much smaller than the former, being only two-thirds of an inch long and of a general reddish-brown colour and slightly hairy (Plate I., Fig. 4). It appears in June and July. The grubs are very similar to the former, but smaller, and can be told by the different sculpturing on their mandibles. The grubs live in the soil for two years.

The Garden Chafer *(Phyllopertha horticola).*

This is quite a different beetle from both the former, and in parts of Great Britain, notably Wales, is more frequent than either of the preceding on Rose bushes. It also attacks fruit. It varies from a little under to a little over half-an-inch in length. The front part of the body is metallic greenish colour, and the wing-cases are reddish-brown (Plate I., Fig. 3). The male is very hairy. The beetles, unlike the two preceding, are active during the day time. They deposit

their eggs as the others do, but the grubs only live a year. This is known as the Coch-y-bonddu in Wales, and is used as a bait for fishing. All these chafer larvæ do much harm to grass land also.

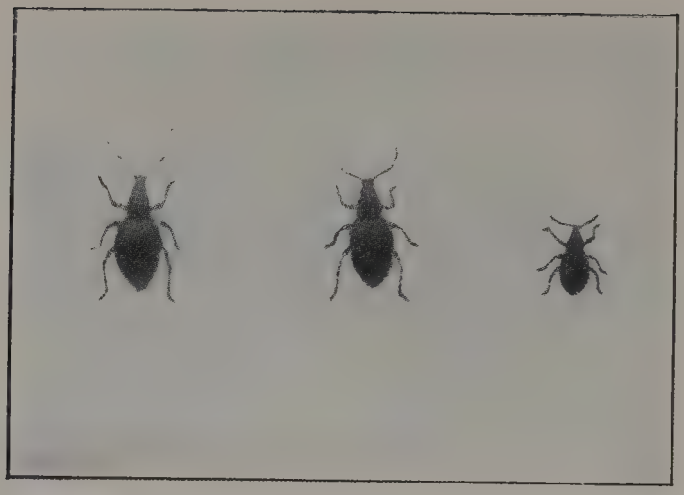
PREVENTION AND REMEDIES FOR CHAFERS.

The rootage of Rose bushes should be examined when signs of unhealthiness are noticeable and the grubs picked out by hand. They may be attracted away from the soil by placing grass turves upside down under the earth where the grubs collect and can then be easily picked out and killed. The Large and Summer Chafers may be collected off the bushes in day time. The Garden Chafer is best sought for when the sun is going down, and also the green Rose Chafer, or on dull days. Nothing but hand picking can be resorted to for these adult Lamellicorns.

Chafer larvæ are readily killed by forking in Naphthalene at the rate of 2½-oz. to the square yard, and if the soil is dry it should be well watered after the naphthalene has been forked in.

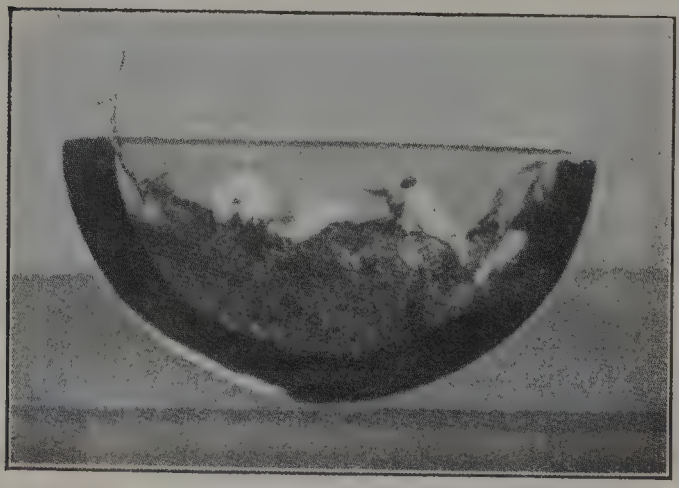
WEEVILS *(Otiorrhynchi)*.

Two species of Otiorrhynchus weevils, one the Raspberry weevil (*O. picipes*) the other the Red-legged weevil (*O. tenebricosus*) have been recorded attacking Roses in this country. The former is clothed with light brown and ashy pubescence and pale yellow-



A B C

A *Otiorlynchus tenebricosus*; B *O. sulcatus*; C *O. picipes.*



D

FIG. 2.

RED-LEGGED WEEVIL LARVÆ.

[Figures from the Insect and other Allied Pests of Fruit: F. V. Theobald, 1909.]

brown scales, which give the wing-cases a tessellated appearance. The red-legged weevil is large, as shown in the figure (½-in.) (see Fig. 2 A). It is shiny black with dull reddish legs. Both are quite wingless. They feed by night and hide away during the day in crevices in the soil, beneath boards, or anything lying on the soil or in the earth, sometimes under leaves or on the dark side of shoots. The beetles fall at the least jar or shock to the ground, where they feign death. The damage they do is by gnawing buds, foliage and tender shoots. They lay their eggs in the ground, and these change to white footless grubs with brown heads, of the form shown in the photograph (Fig. 2 D). The larvæ damage all manner of roots, besides those of Roses.

Another species, the Black or Vine Weevil (*O. sulcatus*), also feeds on the Rose (Fig. 2 B).

The beetles may easily be caught by placing pieces of sacking on the ground where they are working ; they shelter there and so can be easily collected in the day time and killed. Naphthalene kills the larvæ in the soil, used at the same strength as recommended for the chafer grubs.

LEAF WEEVILS *(Phyllobius spp).*

These weevils have been now and again reported as attacking Roses. In May, 1913, they caused considerable damage at Frimley Green, Surrey. The bee-

tles cluster on the buds before they open and make large scars and the blossoms are ruined and to some extent the foliage is damaged. Open blossoms do not seem to be touched. Two species of Leaf Weevils seem to be implicated, namely, *Phyllobius maculicornis* and *P. oblongus*. (Plate I., Fig. 5.) Both these insects also do considerable harm to fruit trees. The first species is brown, clothed with bright green, bluish-green or golden green scales, the antennæ reddish to black, apices club-like, legs black and brown. Length one-fifth to one-sixth inch. The Oblong Leaf Weevil (*P. oblongus*) is about the same size as the former; the body is black, the wing cases covered with dull brown scales with a reddish tinge or pale grey, the border dark almost black, head and thorax covered with grey pubescence and also the wing cases; legs brown to yellowish. These beetles commence work in May and continue to the end of June. On bright, warm days they are very active, in dull weather they are sluggish. The females lay their eggs on and in the soil and the maggots or larvæ feed on the roots of various plants and continue to do so during the winter. These grubs are white, footless creatures, with brown heads, wrinkled skin and with some scattered hairs and soft in texture. They change to pupæ of a pale colour in the soil, the pupæ showing prominently the legs, wing-cases, etc., more or less outstanding from the body. The beetles emerge in May. When they occur in numbers on Roses they may be shaken off

on to tarred boards, or may, if very persistent, be killed by spraying with arsenate of lead. The larvæ have been known to feed on the roots of Roses as well as the roots of bush fruits, pot plants, etc. If they occur in any numbers they are easily killed by forking in crude commercial naphthalene at the rate of 2½-oz. to the square yard.

THE RASPBERRY BEETLE *(Byturus tomentosus)*.

This well-known raspberry and loganberry pest has been sent me as a destructive Rose insect from Hebden Bridge, Yorkshire ; Gloucester and Somerset. The beetles were observed in early June eating the petals of the Roses and had done considerable damage. Its life history is well known, the beetle laying its ova in the blossoms of the fruit mentioned and the larvæ live in the receptacle of the raspberries and loganberries. The small pale brown beetles can easily be jarred off Rose bushes on to tarred boards when they occur in sufficient numbers to be doing any harm.

BEES AND SAWFLIES *(Hymenoptera)* INJURIOUS TO ROSES.

The only Hymenopterous insects which are injurious to Roses are the Leaf-cutting Bees, some Sawflies and, to a very small extent, Ants. The latter may be excluded as pests, as they are mainly found on the Rose bushes when the latter are infested with Aphides, and they will be mentioned when dealing with those insects.

The Rose Leaf-cutting Bee *(Megachile centuncularis).*

This bee (Plate I., Fig. 6) is often very annoying to Rose growers, by the frequent incursions it makes on the foliage, not for feeding purposes, but for taking parts of the leaves bodily away. So persistent are they in attacking certain bushes that they cause almost complete defoliation.

Every Rose grower knows the appearance of the leaves shown in Plate I., Fig. 6a. The curious semi-circular cut-out areas of the leaves shown in the plate are the result of the attack of this Leaf-cutting Bee.

The pieces of leaves are cut out by the bees to form their nests, and for this purpose they use also the leaves of the annual and perennial Mercury, but Rose leaves are their favourite. This bee carries the cut-out sections of the leaves to some tunnel it has formed either in decaying wood or in brick walls and now and again in the ground.

These nests are made first by the removal of wood, earth or mortar, until a cylindical tube is formed, often some inches in length. The female then proceeds to cut pieces out of the Rose leaves to line this tube. She then places an egg at the end and fills it around with a reddish hued substance composed of pollen and honey. This having been done the bee flies off and cuts a circular piece of leaf and

Photo by Mr. Edenden.

ILLUSTRATION 3.

Rose leaves attacked by the LEAF-ROLLING SAWFLY.

shuts in the egg and its attendant food material, several layers of circular leaf substance are added until the cell is firmly sealed up, and so on until six or more cells have been formed (Plate I., Fig. 6b).

Upon the stored-up food the white footless maggots coming from the eggs feed and eventually spin cocoons of silk attached to the sides of the cells, and in the coming season, after passing through the pupal stage, the leaf-cutting bees appear again. We can do nothing to prevent them working in this way, unless it is by following them to their nests and destroying the same at dusk, when the makers are safely housed within.

The Leaf-rolling Sawfly *(Blennocampa pusilla)*.

Very frequently on wild Roses we notice a curious lateral folding over of the leaves. This is due to the larvæ of a sawfly known as *Blennocampa pusilla*. During recent years quite a number of instances of this insect attack have been reported upon cultivated Roses. In some cases to such an extent that no blossom was produced. This was especially noticed by one correspondent in Maréchal Niels, but many other varieties are attacked. This folding over of the leaves is not only disfiguring, but the leaves lose their proper function, and soon shrivel and die (see Illustrations 3 and 4).

One member of the Society writes from Preston that an old Rose bed with 140 bushes has been practically destroyed by this sawfly.

If one of the folds is opened we find inside one or more pale greyish-green or grey larvæ. This folding of the leaves is mainly accomplished by the larvæ, and as far as I can see it is done by them when immature. Cameron, however, says that they are aided by the incisions made by the females when they lay their eggs. The deformity produced in the leaves varies, but the rolls are always more or less cylindrical. When the leaf dies the larvæ may move to another leaf.

In several cases observed personally it was noticed that the attack was most severe when suckers had been allowed to grow, and the attack had apparently started there. At the same time I have had it reported from Stockport and district, from places in Somerset and Kent, where no such evils were allowed. Another report came from Harrow-on-the-Hill that it was a general pest on healthy Roses. Both Teas and hybrids have been mentioned as suffering severely.

LIFE HISTORY AND HABITS.

The sawfly appears in May and June; the colour is black and shiny; the legs, black with whitish knees, tibiæ and tarsi; wings dusky and irridescent. Length one-sixth of an inch. The eggs are laid on the leaf.

Photo by Mr. Edenden.

ILLUSTRATION 4.

Rose leaf attacked by the LEAF-ROLLING SAWFLY.

The larvæ are grey when young, then a green central line appears, and then, as far as I have observed, they become all green, with paler areas at the junction of the segments and they have small but conspicuous hairs on the back; the skin in the later stages becomes somewhat wrinkled, and the head brown and white and shiny. They fall to the ground when full grown and enter the soil in August and at once form a cocoon, in which they remain as larvæ until February or March, when they pupate, and a fresh batch of sawflies comes up and attacks the Roses in early summer.

TREATMENT.

Spraying with nicotine wash has been found to kill some of the larvæ, but by far the best plan is to hand-pick the folded leaves when first seen and destroy them.

There is little doubt that this insect is often introduced into Rose beds with the earth on the roots of briars in the cocoon form.

It is well therefore to see that all earth is cleaned from the roots before being planted. This may be done by well washing them in plain water.

The sawflies do not seem to fly far, but infection may come in this way.

The Rose Slugworm (*Eriocampa rosæ*).

Another sawfly causes endless annoyance in gardens, namely, the Rose Slugworm, an insect which in its larval stage works very much like the Slugworm or Sneg of the pear and cherry.

The larvæ of this sawfly devour the lower and occasionally the upper epidermis and tissues of the Rose foliage. The leaves at first become blotched, then almost white, then brown and shrivelled up, the lower skin always remaining intact. This has been noticed by Cameron and myself in all cases, but some members say that they attack the lower part of the leaves, leaving the upper epidermis intact. This is contrary to the working of *Eriocampa*, and I have never seen this species doing so. Possibly another insect is referred to.

In some years this sawfly is so very abundant in gardens that it not only causes disfigurement, but materially checks the growth of the bushes.

It is especially common on the harder varieties, but will attack all kinds. I have seen it work on Réve d'Or and on Moss Roses so ravenously that not a leaf remained intact (see illustration 5).

LIFE HISTORY AND HABITS.

The sawfly is much like the former—shiny black, the knees, four anterior tibiæ and tarsi, white, and

Photo by Mr. Edenden.

ILLUSTRATION 5.

Rose leaves damaged by the ROSE SLUGWORM.

with smoky wings (Plate II., Fig. 5). Length one-sixth of an inch. The adults occur first in May, when the females lay their eggs in the mid-ribs of the leaves. The larvæ are pale yellowish green, with a darker line down the back, marking the alimentary canal The head is more or less bright orange. When mature they fall to the ground and pupate in the soil in small oval cocoons.

At least two broods occur during the year. The first larvæ are seen in June, the second brood in August; and in 1907 they occurred in September.

This insect is not only very common in gardens in Britain, but also in France, Germany, Holland, Sweden, Denmark and North America.

TREATMENT AND PREVENTION.

It can easily be killed by spraying the Rose bushes with nicotine or hellebore wash,* which is better than dusting with hellebore powder or arsenate of lead.

If there has been a bad attack it is well to have as much as possible of the surface soil removed in winter, and either deeply buried or burnt and fresh mould put over the roots. Naphthalene dug in will also destroy this larva with the other soil insects previously mentioned.

* See pages 102 and 103.

THE ROSE EMPHYTUS *(Emphytus cinctus).*

The larvæ of this sawfly work in quite a different way, for they eat the leaves entirely away. They start at the edge and eat down to the mid rib. Moreover they do harm in another way, for when mature they enter the branches and kill the growth above them.

This latter damage has been reported from Strathpeffer Spa, N.B., and it was noticed that the young shoots flag and show black specks about the tips.

This sawfly is common and widely distributed over Great Britain as well as on the Continent as far as Eastern Siberia.

LIFE HISTORY AND HABITS.

The adult is black, the thorax with white marks, the abdomen with the fifth segment with a white band, which does not reach all round; legs black, base of femora and apex of tibiæ white, rest of tibiæ and tarsi reddish. The female is one-third of an inch long. The male is smaller and has no white band on the body. This sawfly occurs in June, and the female lays her eggs on the underside of the leaves in minute slits. Some seven or eight eggs are placed on each leaf.

The larvæ are found from July to October feeding on the edges of the leaves. The upper part of the body is dark green, the sides pale, the skin is covered with small white spots and is somewhat wrinkled; the head brown, yellow and black ; legs white, with a dark mark over each of them. The front part of the body is somewhat swollen. They hold on by their front feet to the edge of the leaf and curl the rest of the body in all manner of shapes. When at rest they may remain coiled up in a ball on the underside of the leaves (Plate II., Fig. 2).

On reaching maturity the larvæ make their way into the branches and there form a cell in which they pupate in the following spring. When in the shoots they are more or less white.

Treatment is the same as for the previous species.

The chief remedies for sawflies are (1) spraying with nicotine or hellebore wash, (2) removal of surface soil and dead wood during the winter, and (3) hand picking.

Recent investigations have shown that nicotine or tobacco wash is fatal to sawfly larvæ, and thus owing to its non-injurious effects should supersede arsenate of lead, which, even if properly applied, disfigures the foliage.

THE ROSE SHOOT-BORER SAWFLY *(Poecilosoma candidatum)*.

The larva of this sawfly bores down the pith of Rose shoots for from one and a-half to three inches.

LIFE HISTORY AND HABITS.

The larva is dull yellowish-white, yellowish on the head, with dark mouth and eyes. They are found in May and June and early July in the shoots and kill them. The sawfly is black with testaceous legs, some white spots on the thorax, and the edges of all the abdominal segments white. Length rather more than one-fourth of an inch.

The female lays her eggs singly in the tips of young wood. The larva on hatching at once bores into the shoot. When mature it eats a round hole to the exterior and falls to the ground, enters the soil and spins a cocoon. In this case of silk and earth it remains all the winter and pupates in spring.

Cameron says it is a rare species, the only British locality being Oxford. I have found it occurs here and there in Britain, but it is very local.

TREATMENT.

The only treatment can be hand-picking the dying shoots before the larvæ escape.

Other species of sawfly occur on the Rose in Britain, but are not of much importance.

MOTHS *(Lepidoptera)* INJURIOUS TO ROSES.

A large number of caterpillars of moths feed upon the foliage, buds and blossoms of the Rose. At least twenty may be found fairly commonly on this plant, but usually only as isolated larvæ, which do not do much damage.

The caterpillars work in three different ways (1) They eat the foliage (Vapourer moth, Buff-tip, &c.) ; (2) they eat into the unopened blossoms and spin the tender leaves together (Tortrix moths or Rose maggots); and (3) they tunnel into the leaves (Rose Gelechia or Miner). After the Aphides the next worst Rose pests are undoubtedly the Tortrices or Rose maggots.

The caterpillars of moths can be told by the number of their legs. There are two types found on Roses. The first and commonest, such as the Vapourer, has six jointed legs in front, four pairs of prolegs and an anal pair. The second (as the Winter moth) has only one pair of prolegs near the mid region of the body and the hind or anal pair.

A few only of those moths which are found in their caterpillar stage on the Rose can be mentioned here. Those chosen are generally common and often occur in great numbers, so causing marked damage.

The Vapourer Moth *(Orgyia antiqua)*.

The attack of the beautiful caterpillars of this moth on Roses is well known, not only in the country but also in towns. The male Vapourer moth is frequently found in numbers flying about even in the crowded thoroughfares of London and other large cities.

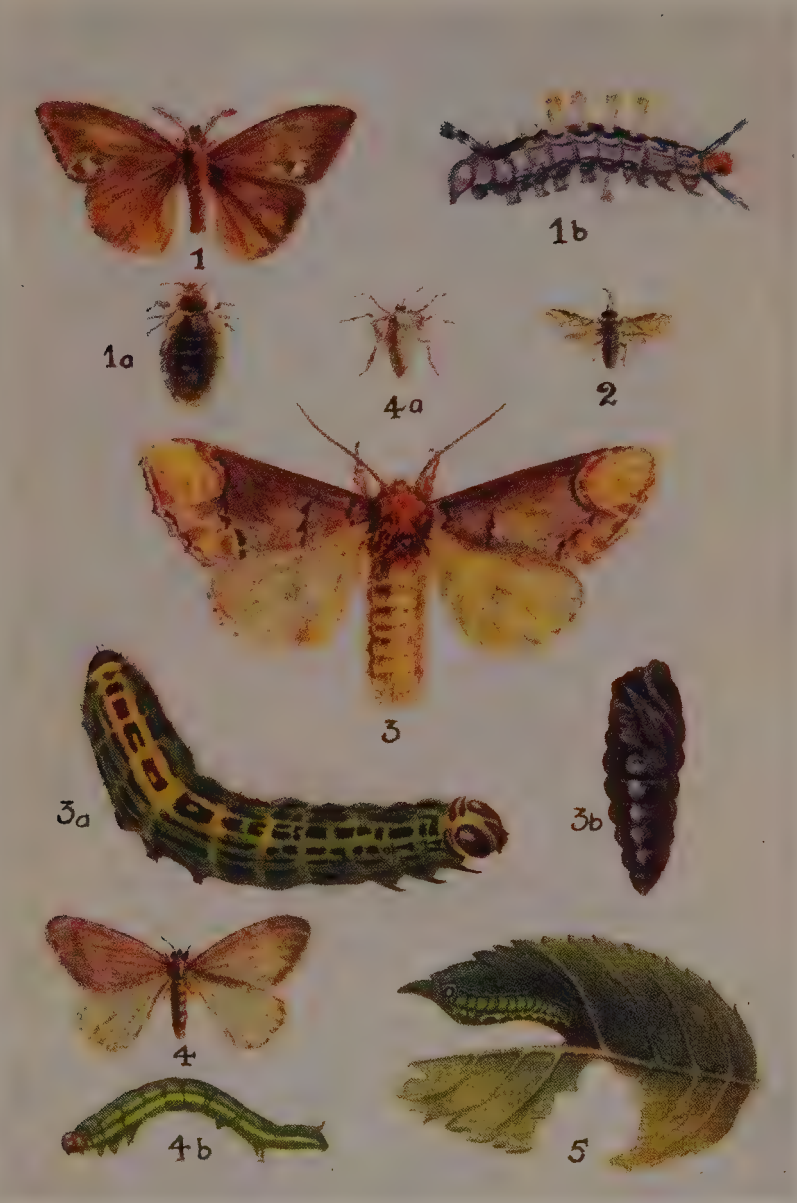
Its distribution is very wide over England and Wales, and it is common in Ireland, especially in the south, but I have had no complaints of its damage from Scotland.

The male moth is winged, of various shades of rich chestnut brown with darker markings on the fore wings and a white moon-shaped mark near the hinder angle; the wing expanse is over an inch. The female is quite wingless, or at least very small traces of wings only are present; she is grey in colour and very plump and reaches about half-an-inch in length (Plate II., Fig. 1).

LIFE HISTORY AND HABITS.

The moths appear mainly in August and September, but may continue into October, and a few have been seen in July; the males fly in bright sunshine. The females merely crawl from the inside of their cocoons to the outside, where they eventually deposit eggs, often completely covering the silken

Plate II.



1, Vapourer Moth, Male. 1a, Vapourer Moth, Female. 1b, Larva
2, Rose Sawfly (*Emphytus*). 3, Buff Tip Moth. 3a, Larva. 3b, Pupa
4, Winter Moth, Male. 4a, Winter Moth, Female. 4b, Larva
5, Rose Slugworm.

case. The eggs do not all hatch at once, but come out a few at a time over a period of some weeks.

The caterpillars are variable in size when mature, ranging from 1½ to 2 inches in length. The colour is dark grey, spotted with small red tubercles, four large upstanding tufts of yellow or brownish hairs on the back, and five long tufts of pin-headed hairs of dark colour, two pointing forwards, two lateral and one long over the tail end (Plate II., Fig. 1b). They mature from June to August and then spin a cocoon of silk mixed with the hairs from their body, either amongst the leaves and shoots or more usually against a fence, or on the trunks of trees. The larvæ then change to deep yellowish brown pupæ, from which the moths appear in two or more weeks.

Fruit trees and hawthorn hedges, etc., are also attacked by the Vapourer moth caterpillars.

TREATMENT.

All cocoons that are seen in the winter to be covered with eggs should be collected and burnt. If there are only a few caterpillars then they may be hand-picked, but if many it is best to spray the bushes with arsenate of lead, for nicotine has not been found successful.

The Pale Tussock Moth *(Dasychira pudibunda)*.

The handsome caterpillar of this moth is called in some districts the Hop-dog. Besides feeding on

hops, birch, oak and hazel, it may frequently be found on Roses, where, owing to its ravenous nature, it soon clears off the foliage.

The moth varies in size from 1¾-in. to 2½-in. across the expanded wings. The male is greyish white powdered with dusky scales, with a short dark transverse streak near the base, and a dusky broad band towards the middle ; the female is larger than the male, with greyish white front wings and the central band pale grey (Plate III., Fig. 4).

LIFE HISTORY AND HABITS.

The moth appears in May and June. Sometimes they hatch out earlier ; I have bred a few even in January. The female deposits her eggs on the leaves ; the ova are bluish-grey in colour and laid in groups, often as many as 150 in a batch. They hatch in three or four weeks. The caterpillars are found feeding from August to October. At first they remain in clusters, their heads all turned together ; after a week they separate and wander over the bush or to several bushes.

The colours of the caterpillars vary very much ; the commonest form is pale yellowish-green in the young stage, becoming reddish or brown later ; there are four dense hairy tufts on the fifth to eightn segments, and between them the colour is deep velvety

THE LACKEY MOTH.
(Female and Male.)

THE LARVÆ OF THE LACKEY MOTH.
(From the *Insect and Allied Pests of Fruit.*)
ILLUSTRATION 1.

black, and also after the last tuft ; the twelfth segment is provided with a dull red or purplish tail-like tuft, and all the rest of the body is covered with hairs (Plate III., Fig. 4a). One form is all yellow, head and sides green, and there are black marks between the tufts. When mature they reach from 1¼ to 1½ inches long ; they then spin a slight silken case amongst the leaves, with some hairs in it, and change to a dark pupa with two pale bands on the body and little tufts of pale hairs. The winter is passed in the cocoon which may fall to the ground with the leaves, or the hop-dogs may make the cocoon on walls and fences and hedgerows near at hand. The same treatment as for the former will apply to this insect.

The Lackey Moth *(Clissiocampa neustria).*

This moth usually lays its eggs on fruit and forest trees and hawthorn hedges, but now and again its caterpillars invade Rose bushes, and being very ravenous feeders do much damage in a very short space of time. The female moth is about an inch and a quarter in expanse of wings, which are brownish-red in colour with a pale band on each front wing. Now and then this stripe is darker than the general colour of the wing ; the body is heavy and very hairy. The male is smaller than the female and usually of a yellowish-brown colour. The moths appear in July and August and the female lays her

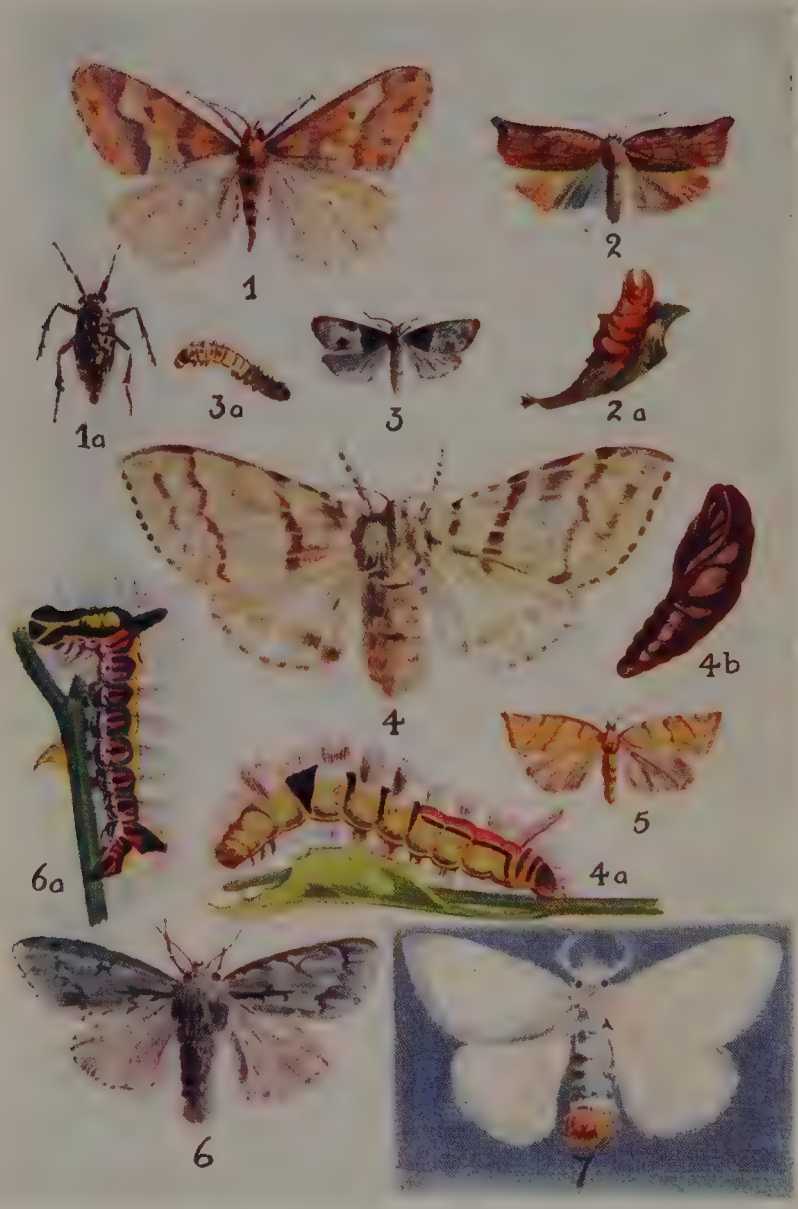
eggs in bands on the smaller twigs and stems of fruit and forest trees. The ring-like egg masses remain on the trees all the winter. The eggs hatch in April and May and the caterpillars spin a tent of silk beneath which they feed in large companies. As they grow they gradually spread out and wander about and it is at this time that they may invade Rose bushes near at hand. When full grown these larvæ are nearly two inches long and are bluish and grey in colour, with longitudinal stripes of orange red, and between the two lowest bands is a broad blue stripe on each side with little black specks, these brilliant lines being separated by black and black-spotted with blue and there is a pure white line down the back, with a narrow dark line on each side ; the head is blue with two black spots and also two on the segment next the head ; over the body are many tawny hairs. When mature they spin a loose cocoon of white or pale yellow silk amongst the foliage, from which the heavy moths emerge in July and August. The larval tents often seen in gardens on fruit trees and hawthorn hedges may reach a foot in length. The larvæ should be collected on Roses by hand.

The Gold-Tail Moth *(Porthesia similis*)*.

Another caterpillar frequently found devouring Rose leaves is that of the Gold-tail Moth.

The moth has beautiful satiny white wings, and

* Also known as *Porthesia auriflua*.



1, MOTTLED UMBER MOTH, MALE. 1a, MOTTLED UMBER MOTH, FEMALE. 2, TORTRIX MOTH (*Toririx podana*). 3, TORTRIX MOTH (*Spilonota roborana*). 3a, LARVA. 4, PALE TUSSOCK MOTH. 4a, LARVA. 4b, PUPA 5, TORTRIX MOTH (*Tortrix heparana*). 6, DAGGER MOTH. 6a, LARVA. 7, GOLD TAIL MOTH.

is found in August, with its wings folded downwards on leaves, palings, lamps, etc. The thorax and abdomen are also snowy white, but the latter has a golden yellow tail tuft (Plate III., Fig. 7). The female is about 1½-in. long ; the male can be told by having a dusky spot on each forewing and is slightly smaller than the female. This insect is widely distributed over Britain, and feeds in the larval stage on a variety of fruit and forest trees as well as the Rose, and is very common on hawthorn hedges.

LIFE HISTORY AND HABITS.

The moths lay their eggs on the leaves. They are placed in golden coloured nests of hairs, derived from the female tail. In from seven to ten days the small larvæ come forth and feed upon the leaves until late in the autumn ; they then go into winter quarters, sheltering in bark crevices, under bark scales, moss, etc., when they spin small dull grey cocoons about one-fourth of an inch long and remain in a dormant condition all the winter. In Spring they come out of these cocoons and commence to feed on the leaves. The caterpillar, when mature, is a brownish-black with a bright red line down the back, a red line on each side spotted with white and another above the legs, and there are numerous tufts of brown hairs.

When mature they reach over an inch in length and then spin a grey cocoon of silk mingled with hairs in which they change to a deep brown pupa.

These cocoons are usually found near the Rose or other food plant, often between the leaves. It must not to confused with the Brown-tail Moth next mentioned.

PREVENTION AND TREATMENT.

When and where these moths are abundant it is advisable to go over the Rose bushes in winter to see if there are any of the small winter cocoons about, and if so destroy them.

The caterpillars, if present in numbers, may be killed with arsenate of lead, or if in small numbers should be hand-picked.

Brown-Tail Moth *(Euproctis chrysorrhœa)*.

The caterpillars of this moth feed on Roses as well as fruit trees and forest trees. The moth is very like the Gold-tail, but the tail tuft is brown. The caterpillars live through the winter in a small tent of grey silk, one end spun tightly to a shoot or branch. In spring the small caterpillars commence to feed and to form large tents of silk ; each winter colony may break up into two or three. The caterpillars hatch in August from round dull golden ova, laid in batches an inch long and covered with brown hairs. The mature caterpillars are deep brown with reddish-brown hairs, a row of white spots on each side, a narrow double broken line of red on the back, dark

between, and with two prominent bright red tubercles on the back of the eleventh and twelfth segments. From the end of June to July they leave their nests, spread out and devour much foliage and later pupate in cocoons amongst the leaves, often many togther. The moths occur in July and August.

This pest is common in France and in other parts of Europe. It occurs in Britain and is common on the Sea Buckthorn on the coasts of Kent and Sussex. It is important owing to the necessity of guaranteeing all exported stock free from this pest that goes to America and the Colonies. It is particularly common in France and may be introduced on Roses from France.

The larvæ can be killed with arsenate of lead. Winter " tents " should be burnt. Its presence must be reported to the Ministry of Agriculture and Fisheries.

The Buff-Tip Moth *(Pygæra bucephala)*.

In late summer and on into the autumn Roses are always liable to be attacked by the caterpillars of the Buff-tip moth. They produce two quite different effects on the foliage according to their age. The young eat the epidermis only and feed in colonies close together. Later they spread out over the bushes and devour the leaves wholesale. A single caterpillar will

do endless damage on a Rose bush. The moth is very beautiful, the fore wings are ashy and silvery grey with two indistinct transverse streaks and a large pale ochreous or buff spot at the tip ; hind wings pale yellowish white. Wing expanse 2½ to 2¾ inches (Plate II., Fig. 3).

LIFE HISTORY AND HABITS.

The moth appears in June and July. The eggs are laid in batches, either on the upper or under side of the leaves ; they are round, the upper part pearly white with a median dark spot, the lower green. They take 10 to 14 days to incubate and are laid in groups of from 20 to 50. The larvæ (Plate II., Fig. 3a) are gregarious and reach two inches in length when mature. The ground colour is dark yellow, a broad black line runs down the back, and on each side are three lines which are interrupted by yellow transverse bands on the segments, and there are fine hairs over the body. They mostly mature by September and reach 2½ to nearly 3 inches in length, and when full fed fall to the ground and pupate in the soil. The pupa is dark brown, about an inch in length, with two spines at the apex. They remain under the trees until the next summer (Plate II., Fig. 3b). They are often very harmful to nut trees and beech and when near Roses they too often pass on to them.

TREATMENT.

The only thing that need be done is to pick off the groups of young larvæ before they disperse. If the large ones are found they can easily be jarred off on to the ground and killed there, or arsenical spraying may be resorted to if the attack is on a large scale.

The Dagger Moth *(Acronycta psi)*.

The caterpillar of the Dagger moth is one of the many omnivorous kinds, which only too frequently feed upon the leaves of Roses in the late summer and early autumn. They usually occur as isolated specimens on the bushes, but owing to their ravenous nature cause much unsightliness and damage. The caterpillar is very marked ; it is greyish-black with a broad pale yellow line along the back and a large blunt black hump on the fifth segment and a short one on the twelfth. It is found from August to October, and when mature reaches 1½ inches long (Plate III., Fig. 6a). It feeds upon the Rose leaves, eating down to the mid rib, and when mature pupates in a cocoon amongst any protection on the ground. The moth appears in June, July and August and is found flying at night in gardens and lanes. The front wings are grey with dark marks as shown in the figure (Plate III., Fig. 6). Length of wing expanse 1½ inches. The closely allied DARK DAGGER (*A. tridens*) is also reported on Roses ; the adult is very similar but smaller. Its caterpillar is

orange-yellow above with a small hump on the fifth segment and a whitish black-crowned one on the twelfth. They may be found every year on Roses in September. As both species usually only occur singly, the simple method of hand-picking alone is necessary.

The Winter Moth *(Cheimatobia brumata)*.

This well-known fruit pest, unfortunately, makes invasions also on our Roses, and in some years does endless damage. Unlike the Dagger Moth larvæ, which come later in the year, the " Canker-worms " or " looper larvæ " of the Winter moth commence their ravages when the Rose leaves are quite young and tender, and they also attack the young leaf and blossom buds.

The Winter moth caterpillar feeds on all sorts of forest trees, fruit trees, shrubs and many ornamental plants. Roses may become invaded when they are near any fruit or forest plantation and now and then infestation comes from Hawthorn hedges.

The writer has seen Roses as badly damaged by this pest as fruit trees when growing in kitchen gardens or near an orchard.

The female Winter moth is shown on Plate II., Fig. 4a, and the male Fig. 4, both natural size.

LIFE HISTORY AND HABITS.

The winged males may appear early in October on to late December, or even January, and are found flying at dark along the hedgerows and orchards, and you will notice them the same in the Rose garden. The females crawl forth from the ground some days after the males have made their appearance, and at once crawl up the Rose bushes. After being fertilised by the males, they lay their eggs on the Rose bushes, both on pruned surfaces and at the axils of buds. The ova are oval, greenish at first, then they become dark, then reddish, and have a sculptured shell. These eggs remain on the Roses all the winter, and from early March to the beginning of April they hatch into small caterpillars, so small we can scarcely detect them. At first they are dark greyish black, then they become green with pale stripes. Their mode of progression is very characteristic, being always in a series of loops. Unlike most caterpillars these Winter Moth larvæ have only one pair of prolegs or sucker feet in the middle of the body, whilst those of the Dagger moth, Gold-tail and Tortrix have four pairs. This character is common to " looper larvæ " (see Plate II., Fig. 4b).

At first they spin the Rose leaves together and later eat into the blossom buds. When full grown, which is some time in June, they attain an inch to a little more in length. On reaching maturity they

fall to the ground, burrow under it and pupate. The pupal stage is passed in the soil in a case (cocoon) covered with earth outside, and in these they remain until the late autumn or winter.

PREVENTION AND TREATMENT.

The method of preventing this pest in fruit plantations is to tie a piece of grease-proof paper around the tree, smear it with some sticky preparation by the first week in October and so catch the females as they ascend to lay their eggs. One would scarcely think of doing this to one's *standard* Roses. Yet it *might be* worth while if the grower suffers from this pest. But we get them on all Roses, and it is better to spray *early* in the season with nicotine or tobacco wash, or if left late in the season with arsenate of lead wash, for then many other leaf-eating caterpillars will also be destroyed (not all, unless done three times in the year with Roses). Moreover nicotine wash will not kill the larvæ after they are half grown. In small Rose gardens hand picking is sufficient.

The Mottled Umber Moth *(Hybernia defoliaria).*

This is another "looper" often found on the Rose. The caterpillar is brown, almost reddish-brown, above, with yellowish sides, and reaches an inch and a half long. It usually appears a little later than the Winter Moth, and although not so common is nevertheless widely distributed as a Rose insect.

The female (Plate III., Fig. 1a) is quite wingless and the male (Fig. I.) is much larger than " *brumata.*"

The Pepper and Salt Moth *(Amphidasys betularia).*

The quaint stick-like caterpillars of the well-known Pepper and Salt Moth (*Amphidasys betularia*), have for many years been sent me as damaging Rose bushes. The caterpillars called " Hop Cats " in the hop gardens of Kent attack also apple, cherry, oak, elm, poplar, birch and hawthorn.

The caterpillars when mature reach two inches long, they are variable in colour, some are green, others dull yellowish, others dark brown, with two pale, almost white, prominences on the ninth and twelfth segments, and traces of paler lines along the body.

The caterpillars are found from late June on even into October. When they pupate they enter the soil and change into brown pupæ.

The moth, which is one of the geometers, varies from 1½ to 2¼ inches in wing expanse. The ground colour is dull white, all four wings being finely speckled with black and brown dots. The moths occur in late May and on to July. The male has more noticeable antennæ than the larger female. The latter lays her eggs on the leaves, as a rule singly. All the larvæ sent me from Roses have been the green variety.

Handpicking is all that is necessary.

The Swallow Tail Moth *(Urapteryx sambucaria)*.

The caterpillars of this moth have often been found attacking Rose leaves. Their usual food plants are ivy, oak, bramble and elder.

The caterpillar is reddish-brown with paler streaks. It is a typical " looper larva " with projections on the ninth to twelfth segments and to some extent on the fourth, the seventh with a lateral protuberance, and two points project from the anal segment. They can be found in the autumn, remaining over the winter and maturing at the end of May or in June. Some sent from Roses at Romford did not mature until July 10th. The mature larvæ reach 1½ inches long. They pupate amongst the leaves, forming a very scanty silken covering, a kind of cradle suspended by threads. The pupa is brown.

The moth is of a fine pale sulphur yellow with two darker transverse lines, which in some specimens may be pale olive colour; the hind wings are the same colour with a darker line partially across them, the hind wings end in a short blunt tail with a dusky spot on each side. The thorax is fluffy and, like the abdomen, is the same colour as the wings. The male is somewhat smaller than the female, but both vary in size. The female usually measures 1¾ inches across the expanded wings, the male 1¼ to 1½ inches. It

occurs widespread over England, but seems to be rarer in the North and unknown in Scotland. Hand-picking the larvæ on Roses is all that is necessary.

The Feathered Thorn *(Himera pennaria)*.

The caterpillars of this moth (Plate IV., Fig. 1a) frequently occur on Roses and a few may do endless damage to the foliage. They normally feed on oaks. The caterpillar is a pale whitish-brown to brown, with two red points just before the tail, now and then they have diamond shaped spots along the back ; they are typical " looper larvæ " without any humps or warts on the back. They are found in May and June. The moths occur in October, the fore-wings are pale ochre to reddish-brown, covered all over with small brown specks, with a round bright spot near the tips, most pronounced in the males, and two oblique transverse darker lines, the orb of which has a pale line on the outer side and between there is a small dark spot ; hind wings pale except near the hind margin, where they are the same colour as the front wings and across them runs a dark line ; the fluffy thorax is ochre to red-brown, the abdomen paler ; the male has beautiful feathered antennæ. (Plate IV., Fig. 1).

The Pale Brindled Beauty *(Phigalia pilosaria)*.

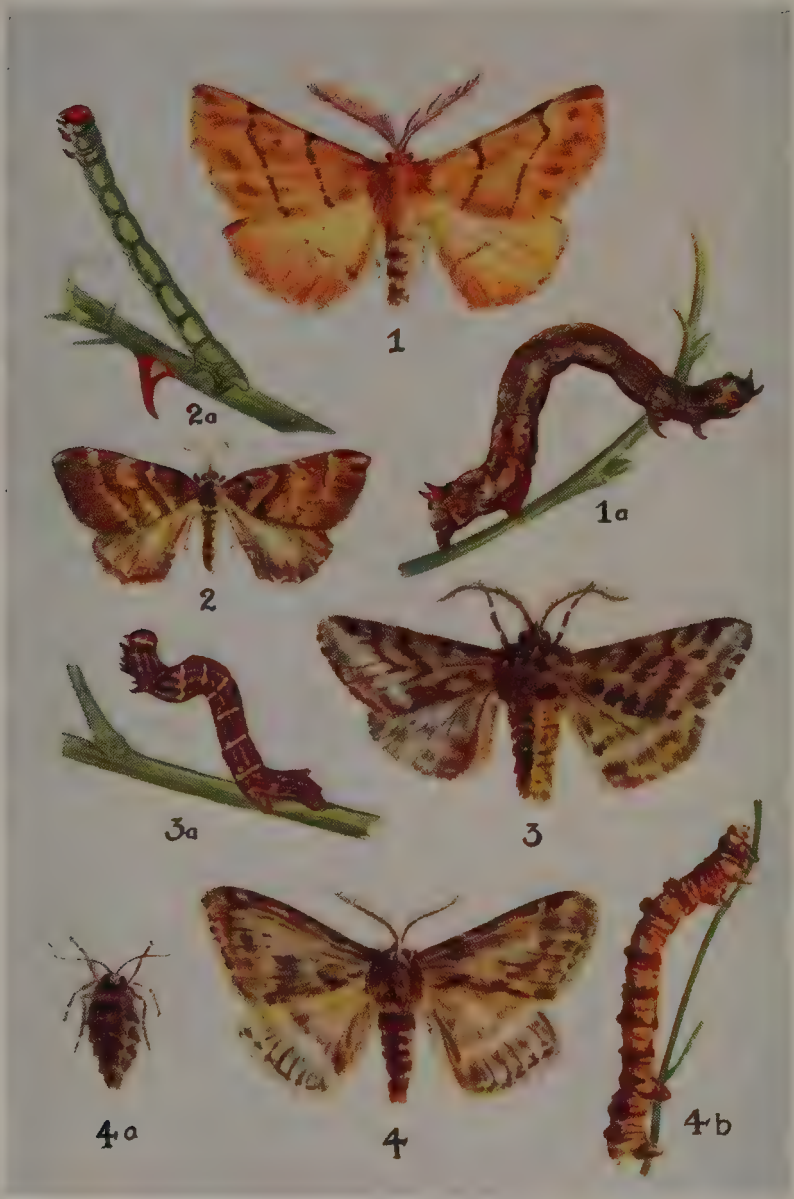
This is another oak-feeder, but it is also found on Roses and may do much harm, and it is a serious pest on fruit trees in some localities. Several Rose

growers have sent me this insect, complaining of the damage done by their larvæ. It is one of the family of Geometers, and like the Winter Moth has wingless females. The "looper" caterpillars (Plate IV., Fig. 4b) reach over an inch in length, they are reddish-brown and brown and in certain stages have dull yellowish markings, whilst the head, legs and tail are rusty red, with wart-like projections. They devour the leaves very ravenously. The moths occur from January to March. The male is about two inches across the wings ; the fore-wings are pale greyish brown with now and then a greenish tinge with four more or less distinct transverse lines of darker hue ; the hind wings are paler with a darker band, both wings appear as if mottled ; the thorax is very hairy and darker than the wings ; the antennæ are feathered. (Plate IV., Fig. 4). The female is quite wingless (4a). The larvæ pupate in the soil.

The Brindle Beauty *(Biston hirtaria)*.

The caterpillars of this moth are also often found on Roses ; normally they feed on pears, plum, apple and lime. The larva (Plate IV., Fig. 3a) is dingy purple and reddish-brown, the colours being arranged in alternate stripes from head to tail, each two stripes being divided by an irregular black line, on the back of each segment are two small raised yellow spots and a ring of the same colour just behind the head and a row of seven yellow spots or bands on each side ; the

PLATE IV.



1, FEATHERED THORN MOTH. 1a, LARVA. 2, SHOULDER STRIPE MOTH 2a, LARVA. 3, BRINDLE BEAUTY MOTH. 3a, LARVA. 4, PALE BRINDLE BEAUTY MOTH; MALE. 4a, FEMALE. 4b, LARVA.

head and legs pink, dotted with black. The caterpillar is found in late May on to July. The moth (Plate IV., Fig. 3) appears in April. Both male and female are winged. The wings are smoky-brown speckled with minute dots of yellowish brown. The male has the fore-wings with six irregular indistinct narrow black bands; the hind wings are more smoky coloured and more transparent with three transverse wavy lines of black. The female wings are more transparent than those of the male. The male antennæ are beautiful feather-like appendages, the female are thread-like; the thorax and body very hairy and the same general colour on the wings. The larvæ pupate in the soil.

The Shoulder Stripe *(Anticlea badiata)*.

The caterpillars of the Geometrid Moth often occur on Roses, both wild and cultivated, and in some gardens may do no little damage. The moth appears in April and May. (Plate IV., Fig. 2). The front wings are sienna brown, with the base and a broad hind marginal band umber brown, the median band pale wainscot brown, which area contains a small round discordal spot, and about the middle of the marginal band is a white lunule, and the whole wing except the median area is traversed by slender dark brown lines; the hind wings are grey, tinged with brown, with slender waved transverse lines across the middle and a broad somewhat darker marginal band; head and thorax

deep brown, body pale brown with two dark spots on each segment. The female lays her eggs in April on the buds and stems of the Roses. The caterpillar is at first green, but varies as it grows ; the head is orange with two black spots, the body may be shaded with purple, especially at the sides, and there are white dots on the segments; the sides of the front segments are red brown, the sides and venter of the others dingy white ; spiracles black ; legs green. (Plate IV., Fig. 2a). It feeds on the foliage and becomes full fed by May or June. When at rest it is stick-like, being nearly in a straight position, holding on to the stem or leaf by its clasping legs. When mature it descends to the soil and pupates on or just under the surface of the soil in an earthen cocoon.

THE TORTRIX MOTHS OR "ROSE MAGGOTS."

These little moths, of which many occur feeding on the leaves, blossoms, etc., of Roses, are frequently of such a serious nature that they completely destroy the first blossoming.

The Tortrices are all small moths, seldom more than three-quarters of an inch across the wings. The fore wings are truncated at their apex. The larvæ, or caterpillars, often called "Rose maggots," are typical, having six jointed legs in front, four pairs of sucker feet in the middle of the body, and a pair at the tail end (Plate III., Figs. 2, 3 & 5).

There are no popular names to many of the different species, a few only of which are mentioned here.

The Red Rose Maggot *(Pardia tripunctata)*.

From personal observations I should say this is one of the two worst species of Tortrix. The " maggots " eat not only the leaves which they spin together, but also eat their way into the blossom buds and quite ruin them. Moreover, their " frass," or excreta, frequently accompanied with a brown moisture, disfigures the leaves below.

This larva or maggot is dirty reddish-brown, with a black head. As it matures it grows fat and sluggish and reaches about half an inch in length. They are found in May, June and July. On reaching the full fed stage the " maggot " changes to a dark brown pupa, which is spun up amongst the leaves more or less enshrouded in pale silk.

The moth appears in May and June, and, it seems, again in the late summer. Its fore wings are smoky-brown at the base, then whitish with grey clouding, leaden towards the tip with four small black specks; under wings grey. Length, about two-thirds of an inch. It is generally abundant in gardens.

The Brown Rose Grub *(Spilonata roborana)*.

Another very common and harmful species, which is shown on Plate III., Figs. 3 & 3a, the fore wings

dark brown at the base, the mid area white speckled with grey, tip darker, a leaden grey spot on the inner corner and brown palpi. Length, about the same as the former species. This moth is found on the wing in June and July. The maggot is a dull brown with a black head, and like the former becomes very fat as it matures. They especially occur on the shoots, the young leaves of which are spun together and the buds eaten into. The damage done by them when they are nearing maturity in May and June is very marked. The date of appearance is in early April in some years, late April in others. Pupation takes place in tightly spun up cocoons formed partly of a rolled piece of leaf.

The Allied Tortrix or Green Rose Maggot *(Tortrix heparana)*.

This is a common moth on fruit trees, Roses, etc. The moth (Plate III., Fig. 5) has pale dull ochreous to reddish brown fore wings with dark brownish red markings, including a basal patch, a central area, broadest in the middle, with its inner edge rather angulated ; the hind wings are slatey-grey with a yellowish fringe. It appears in the moth stage in June and July. The larva is bright green, with darker dorsal line and a green head.

***Tortrix podana* (another Green Rose Maggot).**

This is another common Tortrix on Roses. (Plate III., Fig. 2). It also attacks all fruit trees and bushes, oaks, etc. The female appears in

June and July and varies from a little over an inch in wing expanse; the front wings are dull drab to brown, with a rosy hue, the whole surface, particularly the apex, reticulate with dull chocolate brown; near the base is a curved line, followed by another before and a third beyond the middle of the costa, a fourth line runs along the apex, followed by a curved wedge-shaped mark on the latter, of a black or deep brown colour; hind wings with posterior half fuscous, apical half rich yellow, speckled with fuscous. The male has the anterior wings smoky-pink, the apical area ochreous with dark marks; smaller than the female. The larva is grass green, with darker dorsal vessel; head shiny chestnut brown; the shield greenish white in front, then white, then black at the base; the spots on the body are jet black and shiny; anal segment pale green. Less than 1-in. in length. The chrysalis is half an inch long, fuscous beneath, chestnut brown on dorsum towards the head. (Plate III., Fig. 2a.)

The Yellow Rose Grub *(Crœsis holmiana).*

This pretty little moth is often very plentiful in gardens and lays her eggs on Apple and Rose. It occurs in June and July. The fore wings are dark orange, suffused with lead colour at the hind area, and with a prominent white triangular spot on the costa; hind wings grey. The larva is yellowish with a pale reddish-brown head.

Another pretty species is *Crœsia bergmanniana*, whose forewings are pale yellow, reticulated with orange, with a silvery bluish transverse line before, a second beyond the middle and another on the hind margin. It occurs from June to August. The maggot is pale yellowish-green; the head and second segment black. It is most noticeable in May and June. Some growers have told me this is a serious enemy.

So many others occur in different localities that it is impossible to deal with them here.

TREATMENT FOR ROSE MAGGOTS.

The most general plan is to wait until we see the buds being eaten, the leaves ruined, and then pinch the grub in the leaf and kill it.

What we want to do is to prevent these creatures from doing any damage, and this can only be done by spraying with nicotine wash early in the year, say not later than the middle of April. Perhaps this will have to be done twice, but at the same time we poison many of the other Rose caterpillars.

During experiments carried out in 1909 and since with nicotine for caterpillars on fruit trees, I at the same time tried it for Rose grubs and found it more successful on the young grubs than arsenate of lead, owing to its penetrative properties, and strongly advise all Rose growers to use this insecticide, which kills aphis, thrips, leaf-hoppers, etc., at the same time.

The Rose Leaf-miner *(Nepticula anomalella)*.

The leaves of Rose bushes in the months of July and October are frequently found to be marked with serpentine pale tracks, with a dark central line (Plate V., Fig. 4). On opening one of these we find inside the tunnel a small amber-yellow, semi-transparent maggot with a dark yellow central line with a dark head ; in size about one-sixth of an inch. (Plate V., Fig. 4a.)

This is the larva of a minute moth—one of the *Tineinæ*, a group of very small moths with long fringes to their wings. This attack on the leaves is sometimes quite harmful, but it is mainly the coarser kinds of Roses that are troubled with this pest.

LIFE HISTORY AND HABITS.

The moth appears first in May. The wing expanse is little more than one-sixth of an inch. The front wings are pale bronze, a little paler beyond the middle, the apex abruptly dark violet and the fringe long and grey; the hind wings are grey with pale cilia; thorax the same colour as the base of the wings and the body dark grey (Plate V., Fig. 1). We find them resting on the Rose leaves, and on palings, stakes, etc.

The egg is laid on the under surface of the Rose leaf close to a rib, and the larva on hatching a few

days bores into the leaf and gradually forms the tunnel, leaving its " frass " behind, thus forming the dark central line. When full grown the larva opens the upper skin of the leaf and crawls out and proceeds to the footstalk of the leaf and there spins a small orange-coloured cocoon in which it pupates. From this the moth hatches in two or three weeks. There is a second brood in August, and the same takes place again.

The larvæ of this second brood, however, pupate in the cocoons attached to the stem, stalk or under a thorn, and also in the ground (Plate V., Fig. 4B). There they remain as pupæ until next May. We may find the larvæ of the second brood in tunnels as late as November. This leaf-miner is generally distributed over the south, west, east and middle of England.

TREATMENT.

When it is plentiful it is well to go over the bushes in June and pick off all the mined leaves and burn them.

So far, no good results have been obtained by spraying.

FLIES *(Diptera)* INJURIOUS TO THE ROSE.

The Red Bud Maggot *(Clinodiplosis oculiperda Rübs)*.

In Germany the buds of freshly budded Roses are frequently eaten by small red maggots. The same

pest has already been found in France. Numerous complaints have been received in England of similar damage. The larvæ are small red footless creatures about one-sixth of an inch long, and belong to the family of Gall Midges or Cecidomyiadæ. They can be told when examined microscopically by having a so-called anchor process beneath the head end. The larvæ found in Britain appear to be the same as those found in Germany, namely, *Clinodiplosis oculiperda Rübs.* The small midge hatches in June and may continue until mid August. The female is said to lay six to twelve eggs in each bud, but in this country I have not seen more than three maggots in each budded area.

I have received the same larvæ from apple trees, where it lives in a similar manner. The damage caused to newly budded Roses has been reported to me from Woking as being quite serious and new to the locality. To check this pest is easy if, instead of the usual rafia for binding, wool soaked in naphthalin and linseed oil is used. Surface budding should be protected by earthing up.

APHIDES, SCALE INSECTS, FROG-HOPPERS AND LEAF-HOPPERS *(Hemiptera)*, INJURIOUS TO ROSES.

We find three groups of the piercing-mouthed insects to be harmful to Roses in this country, namely, (i) the Plant lice, Green fly or Aphides, (ii) the Scale insects, and (iii) the Leaf-hoppers and Frog-hoppers

or Cuckoo spit insects. The two first-named belong to the Hemiptera-homoptera (with transparent wings), the last to the Hemiptera-heteroptera, in which the anterior wings differ from the posterior in texture. All the Hemiptera, we must bear in mind, are sucking-mouthed insects, which are provided with a long proboscis, which they insert into the tissue of the plant and suck out the sap (haustellate insects). We must also remember that they develop by an incomplete metamorphosis, and thus feed during most of their life. Many, as we know only too well is the case with the plant lice, are very harmful to vegetation. Plant lice have most remarkable reproductive energy, increasing very rapidly at certain times and under certain favourable conditions, which we cannot foretell and about which we know little or nothing at present.

Green Fly or Rose Aphides ***(Macrosiphum rosæ, Macrosiphum dirhodum, Capitophorus rosarum, Macrosiphum solanifolii, etc.).***

The Rose Aphides or Green Fly belong to nine distinct species. As is well known, they are the bane of the Rose grower's life, owing to their extraordinary rate of increase, and their persistent attack resulting in serious damage to the young shoots.

A general account of plant lice is given first. A tabulated list of the Rose Aphides is appended and description of them.

1, ROSE LEAF MINER MOTH. 4, LEAF TUNNELLED BY ITS LARVA. 4a, THE LARVA. 4b, THE COCOON. 2, LACE-WING FLY. 3, CUCKOO SPIT INSECT (6 times enlarged). 3a, CUCKOO SPIT. 5, LARGE ROSE APHID (*M. rosæ*), APTEROUS FEMALE. 5a, ALATE FEMALE. 5b, CLUSTER ON SHOOT. 6, SYRPHID FLY (*Catabomba pyrastri*). 7, LADY BIRD (*Adalia bipunctata*) 8, ROSE LEAF HOPPER. 8a, DAMAGED LEAF.

The Aphides are insects which have winged and wingless forms of females, and these females may be of two kinds—those which produce their young viviparously and those which deposit eggs. Then there are males, which may or may not be winged. The sexual forms (oviparous females and males) occur in the autumn.

The simplest form of aphis is the apterous viviparous female.

This female is in the form of a more or less globular body, the head, thorax and abdomen more or less merging into one mass. All that we need note here is the presence of the cornicles or honey-tubes, the curious glands in the skin, and the two-jointed feet (Plate V., Fig. 5).

The cornicles are two tubular horns on the upper surface of the abdomen, near the end, through which the insects pass out a sweet, gummy excretion. Honey-dew is also formed by them and passed out by the anus and is one of the causes of the dying of the Rose leaves, for it falls from the Green fly, covers the leaves and prevents respiration. Later it becomes covered with excrement and a black fungus growth. The glands on the back are also important to remember, because it is through them that the skin becomes covered with a mealy, waxy, or thread-like substance that repels water, and hence, if we wish to corrode

the skin or reach the breathing pores or spiracles we must use something that will hold the corrosive or asphyxiating substance.

The structure of the foot at once separates the aphis or green fly from the scale insect, which has only one segment forming the foot. The respiration of an aphis is, as in all insects, by means of breathing pores at the sides of the body. To kill them these pores may be closed by some sticky substance such as soft soap, which will also hold the poison nicotine on them and so allow it to penetrate their bodies. One of the most remarkable things in the bionomics of the Aphides is the extraordinary rate and method of reproduction.

During a great part of their life-cycle they reproduce asexually, that is without the presence of a male aphis. This method of producing their progeny alive is called *parthenogenesis*. It may continue for several generations. The young themselves soon reach maturity and reproduce again.

Normally the life-cycle is as follows :—In spring we start with what is called a Mother Queen or Stem Mother—a wingless female. This parent produces (asexually) living young—called " lice," really the larval stage. These larvæ soon mature and produce other wingless females, and so on until the plant

becomes smothered (Plate V., Fig. 5b), and then the wingless forms develop wing-buds—in fact become pupæ, which give rise to winged females which fly off to other plants and produce wingless creatures like their parents (Plate V., Fig. 5a).

These winged forms may fly off to the same kind of plant, for instance from one Rose to another, or they may fly off to quite a different sort of plant, as from the Rose to corn or the teazel, or potatoes, etc.

This migration is very important to notice.

In any case, at the end of the season there are produced males as well as sexual females. These autumn females are called the oviparous or egg-laying generation, and they, after having been fertilised by the males, deposit eggs upon the plant. The oviparous females are wingless and usually have the hind tibiæ enlarged.

The eggs remain all the winter in the axils of buds, on the stems, leaves, &c. They are visible to the naked eye if searched for carefully on the Roses. In form they are spindle-shaped, the shell is shiny and the colour black. When freshly laid the ova are yellow or green.

Thus we have during the summer, reproduction

by asexual method, in autumn sexual reproduction occurs and eggs, not living young, are produced.

The rate of reproduction in plant lice is enormous, under certain conditions. Hence the reason we find the tips of the Rose shoots suddenly covered with green and red fly. A single winged female has settled there, and in a day or so has produced many living young, which in their turn are seen to be doing likewise.

Nine well-marked Aphides occur on the Roses in this country, namely, *Macrosiphum rosæ, Macrosiphum solanifolii, Macrosiphum dirhodum, Capitophorus rosarum, Capitophorus tetrahodus, C. neorosarum, Pergandeida flavus, Hyalopterus dilineatus* and *Lachnus rosæ.*

The first-named lives, as far as we know, permanently on the Rose, also on the Scabious and the Teazle. The second migrates to potatoes, etc.; the third goes to corn and grasses. The fourth, fifth and sixth seem to occur only on the Rose. The last occurs on the roots.

The migration accounts for the often sudden disappearance of the " fly " from Roses, and their equally sudden re-appearance in September, and in the case of *M. rosæ* sometimes as late as October.

British Rose Aphides and How to Easily Separate Them.

1.—Honey tubes or cornicles, long :—

(*a*) Frontal head-lobes large and sloping outwards ..... Genus *Macrosiphum*

Honey tubes, black ..... (1) *rosæ* (Linn.)

Honey tubes, green—

Cornicles reticulate at apex

(2) *solanifolii* (Ash)

Cornicles not reticulate at apex

(3) *dirhodum* (Wlk.)

(*b*) Frontal lobes prominent, directed upwards or inwards with a median process on head

Genus *Capitophorus* (V. d. Goot)

Capitate hairs on head, not on body

(4) *rosarum* (Kalt)

Capitate hairs on head and body—

Cornicles green in alate female

(5) *neorosarum* (Theo)

Cornicles black in alate female

(6) *tetrahodus* (Wlk.)

2.—Honey tubes, short :—

Cauda very long, broad and large

Genus *Pergandeida*

Apterous female, green ; alate female with head, thorax and patch on body black

(7) *trirhoda* (Wlk.)

Cauda not so prominent...Genus *Hyalopterus* (Koch)

Apterous female, green with black markings ; alate female with body all green

(8) ***dilineata*** (Buck)

3.—Honey tubes cone-shaped. Genus *Lachnus*.

Feeds on roots.....(9) *rosæ* (Cholod)

1.—The Common Large Rose Aphid *(Macrosiphum rosæ.* Linnaeus.)

This is certainly the commonest Rose Aphid. The apterous female is green or red, with long black cornicles, and yellowish or yellowish-green tail. The winged female has the head and parts of the thorax black, a shiny green abdomen with three large black spots on each side, behind the cornicles a black patch at their base and a black crescent shaped mark in front of them, two dark spots behind the cornicles and sometimes a dark patch on the last segment. The long cauda or tail is green and the cornicles long, thin and black. The egg-laying female is wingless and rusty red, with black cornicles ; the hind tibiæ of the legs swollen. The male is winged, black with yellowish green abdomen, the latter with a row of black spots on each side ; cornicles dull yellow with black tips. This common Aphid lives also on the wild and cultivated Scabious and the Teazle (*Dipsacus sylvestris*). It winters on Roses in the egg stage and migrates to the Teazles, etc., but may continue to live and breed on Roses all the year against warm walls, etc. Migrations from the Teazle may keep on infesting Roses for some weeks and so constant spraying may be necessary to hold it in check.

2.—The Green and Pink Rose and Potato Aphid

(*Macrosiphum solanifolii.* Ashmead.)

This large green Aphid occurs on Roses, potatoes and very many other plants. It winters on Roses in the egg stage, also on potato tubers, etc. It often occurs in very large numbers and is common to Europe and America. It occurs early and late on Roses, both wild and cultivated. The alate female is green or pink, with yellowish-green thorax with dark lobes ; the long straight cornicles are green with dusky reticulate apices, tail green and long. Legs same colour as the body with small dusky bands on apices. Length one-twelfth to one-eighth of an inch. The apterous female is all green or pink, with dusky leg bands and apices to the honey tubes.

3.—The Green Rose and Grass Aphid

(*Macrosiphum dirhodum.* Walker.)

This occurs in some localities commonly, in others it is absent. When it leaves the Roses it flies to various grasses and later returns to the Roses to lay its eggs. The alate female is green, the thorax buff, the lobes pale brown ; the green abdomen has either a dusky green stripe or a row of dusky spots ; honey tubes pale green with dusky apices. The apterous female is green to yellowish, the apex of the body dusky with two irregular wavy lines down the back. Antennæ and cornicles pale green.

4.—The Small Green Rose Aphid (*Capitophorus rosarum.* Kalt).

This is a much smaller Aphid, which occurs on both wild and cultivated Roses all the year round and which may be told from the other *Capitophori* by the absence of capitate hairs on the body. It clusters in masses mainly under the leaves. It seems to be commonest in North Wales and North England. The alate female is green with deep olive green head and thorax, the lobes being much darkened ; the green abdomen has dark lateral spots and darker markings behind. Cauda or tail and the cornicles deep olive green to brown. The apterous female is green, except the tarsi and apices of the honey tubes ; antennæ are short, about one-third the length of the body ; the hairs on the head are capitate and some are at the base of the feelers. The cornicles are long and cylindrical, but slightly swollen on the apical half. It is also known as *Myzaphis rosarum.*

5.—The Hairy Green Rose Aphid

(*Capitophorus neorosarum.* Theobald.)

This is also found on both wild and cultivated Roses, but especially the former. It does not appear to me to do much damage. The alate female is green and not hairy, the head deep olive-green, also the thorax, the lobes brown. The antennæ are dark and the abdomen is green with black transverse bars and four black lateral spots. Cornicles green, cylindrical and long. Tail green. Head hairs capitate. Length

one-twelfth to one-sixteenth inch. The apterous female is green, long, oval, flat ; the head hairs are long and capitate and the hairs on the body are capitate and numerous, especially at the tail end. Length one-sixteenth to one-eighteenth of an inch.

6.—Walker's Rose Capitophorus (*Capitophorus tetrahodus*. Walker).

This is very much like the former insect and seems to live entirely on Roses ; it is not generally common, but now and then causes considerable damage. The alate female has a black head and thorax and a dark green abdomen with a row of black spots on each side and now and then black bars and spots in front. Antennæ dark. The apterous female is green with a whitish bloom, the body with capitate hairs. Antennæ about half length of the body ; cornicles green, brown at the tip.

7.—The Rose and Columbine Aphid (*Pergandeida flavus*. Kittel.)

This is Walker's Rose Aphid (*Aphis trirhodus*). It lives on Roses and Columbines, or *Aquilegias*, and migrates to the latter in summer from the Roses. On the columbines it very often does much harm, living in colonies below and above the leaves which become pale red or purple. As many as 60 insects may occur in each group. They become winged from late August up to October and fly back to the Roses where the sexual forms occur and the oviparous females lay

their eggs on the Rose bushes. On the latter they occur in small colonies on the leaves up to the end of May or June, when they assume wings and fly to the columbines. The apterous female is pale apple green, oval and smooth and slightly mealy ; the antennæ shorter than the body ; cornicles very small and green ; the tail yellow to green and very large, quite four times as long as the cornicles. Length one-sixteenth to one-eighteenth of an inch. The alate female has a black head, thoracic lobes, a patch at the base of the body and a broad irregular patch on the dorsum of the abdomen ; the cornicles are short and green ; the tail large, at least three times as long as the cornicles.

8.—Buckton's Rose Aphid (*Hyalopterus dilineatus*. Buckton).

This marked Aphid does not appear to be very common. It occurs right through from April to the winter on Roses when the sexuparæ are formed. It often occurs mixed up with colonies of the Rose Macrosiphum (*M. rosæ*). The apterous female is pale yellowish-green to bright grass-green with two prominent dark green irregular lines down the back ; antennæ much shorter than the body ; tail long and bluntly acuminate, pale green. Cornicles about half the length of the cauda. The alate female is pale green to yellowish-green ; head, thoracic lobes, etc., black and shiny ; the abdomen is shiny and in some there are darker green transverse bars ; cauda or tail green ; cornicles small.

9.—The Rose Root Aphid (*Lachnus rosæ*. Cholodkovsky).

This large Aphid which occurs on the roots of Roses on the Continent has been found at Wisley in Surrey. A look-out should be kept for this insect, especially on plants coming from abroad.

Aphis Enemies.—Fortunately the Aphides have many natural enemies, which to some extent keep their numbers down.

The more important of these are shown on Plate V., namely, the Lady-bird beetles (*Coccinellidæ*) (Fig. 7), the Hover flies (*Syrphidæ*) (Fig. 6), the Aphis Lion or Lace wing flies (*Chrysopidæ*) (Fig. 2), various Chalcid flies.

The last-mentioned lay their eggs in the Aphides, and the maggots feed on the Aphides internally. They, as it were, hollow them out, and we find the dried skins as pearl-like bodies sticking to the leaves and shoots.

The Lace-wing fly lays her eggs on curious long stalks on the leaves, feeds upon Aphis in its larval stage, the larva being provided with large sickle-shaped jaws for picking the green fly off the plants, and to enable them to suck the juices from them.

Hover Flies, or *Syrphidæ*, drop their white eggs amongst a colony of " dolphins," and the resulting

maggots feed ravenously upon them. The larvæ are rather horrid creatures, somewhat leech-like in appearance and green, grey or reddish in colour.

The Lady-birds do good in both stages, for adults and larvæ (" niggers ") feed upon these pests incessantly.

In spite of all these " natural checks " the Roses become covered and spoilt by plant lice, and man has to help himself and cannot rely on nature to do everything. Ants are usually found amongst a colony of Aphides ; they go to them to extract the honey-dew. Undoubtedly ants carry Aphis about and so may set up attack on Roses. Ants, therefore, should be killed. If their nests are found naphthalene applied thrice at intervals of two weeks will do this, especially if forked into the nests and well watered in.

PREVENTION AND TREATMENT.

It is quite impossible to do away with the second host plants of *M. dirhodum,* but some good may be done by keeping all teazels away from our gardens and rosaries, and so check the *M. rosæ,* but as Aphides migrate for considerable distances one can place no reliance on such methods.

Aphis may easily be kept in check on Roses by spraying, but this must be done with care. The writer

has seen Roses as badly damaged by the washes used as by the green-fly.

The reason is the Rose will *not* stand any strong spray. A particular Rose may do so at one time, but at another it will have its foliage ruined.

Moreover, a strong corrosive wash is not necessary to kill Aphides. For the spraying of Roses you must get the best soft soap, and not use more than 1-lb. of soap to 25 gallons of water. To this may be added 2½-lbs. of quassia chips. The effect of the latter is undoubtedly most beneficial, for it acts as a stimulant and cleanser to the leaves, and by many growers is said to have a direct effect on the Aphides. The soft-soap, of course, has some corrosive power, for it may contain caustic soda (about 4 per cent.), but its main effect is to act as an asphyxiator by blocking up the breathing pores and as a holder of any poison like nicotine on to the insects.

This soft-soap and quassia wash is made as follows:—Dissolve the soap in boiling *soft water*; boil the quassia chips or let them simmer for about 12 hours, adding water enough to keep them covered, every now and then strain off the liquid extract and pour into the dissolved soft-soap and well stir, and lastly add the full quantity of water of dilution. This is all that is required to kill Aphis. But we must

remember two things, first that the living young inside the females are *not* hit by the wash, and that the wash does *not* kill the females at once. So many young will escape before the parents die, and even have been seen protruding forth after their death.

To clear the Roses, then, we must spray twice in succession at a few days interval if we use the soap and quassia wash.

Nicotine wash is in fact the best insecticide and may be safely used with soft-soap. It is made as follows: ¾ to 1-oz. of 90 p.c. nicotine and 2-ozs. of soap to 10 gallons of water; and as it kills young Caterpillars, Leaf Hoppers, Cuckoo Spit and Thrips, it is the best to use.

Paraffin emulsions of various strengths and forms have been recommended. They are usually harmful to the bushes, and the corrosive paraffin is not necessary for the purpose. Growers should be cautioned against its use. It is frequently found advisable to wash the bushes with plain soft water two days after spraying, partly with the object of removing any soft-soap from the leaves, and partly to knock off the dead Aphides, etc. This applies to any of the aphicides used, but I have found it is not advisable to do so when nicotine wash has been used, for if it is left on it acts as a preventive for some days.

Scale Insects (*Coccidæ*).

So far two species of scale insects have been reported to me as doing harm to Roses in this country, namely, the Scurvy Rose Scale (*Diaspis rosæ*), and the Brown Scale (*Lecanium persicæ*). Newstead also records *Lecanium capreæ* on Roses. Mealy Bugs also attack Roses under glass.

The scale insects are very harmful and many have a very wide distribution, being so easily carried from place to place on nursery stock and plants in general.

They are most interesting insects on account of their strange bionomics.

The " scales " which we notice on the Roses in the case of the Scurvy scale are products of the insects. Beneath the scale the female lives and degenerates. She produces eggs, and from these hatch out little six-legged active larvæ, which make their exit from beneath the scale. They wander about and eventually fix upon some spot on the Rose bush. The young scale insect is provided with a long piercing mouth, and this is inserted into the plant tissue. After this an excretion is gradually formed over the back which, with the insects' cast skins (so-called exuviæ), becomes the " scale." During its formation the active six-legged larva degenerates into a footless fleshy mass, the female.

If the larva is destined to become a male a different shaped scale is formed and the larva becomes a kind of pupa—a so-called pro-pupa from which a winged insect is produced. The male scale insect escapes from under the covering and flies about. It has two wings and a long projecting penis by means of which the females are fertilised under their scaly covering.

Many scale insects reproduce like the plant lice, that is asexually.

Such scales as the brown scales (*Lecanium*) have no true "scales"—the skin of the female merely hardens and forms a house as it were for the eggs.

Others as the mealy bugs (*Dactylopius*), which may occur on Roses under glass, have no scale at all. They are active all their lives.

Scale insects are preyed upon by much the same enemies as Aphides, especially Lady-birds, Chalcid flies and birds, but none are equal to keeping them entirely in check.

The Scurvy Rose Scale *(Diaspis rosæ)*.

This insect, often called the Scurvy Rose Bug, is quite a common scale insect on wild Roses in the West of England, and I have found it on the bramble.

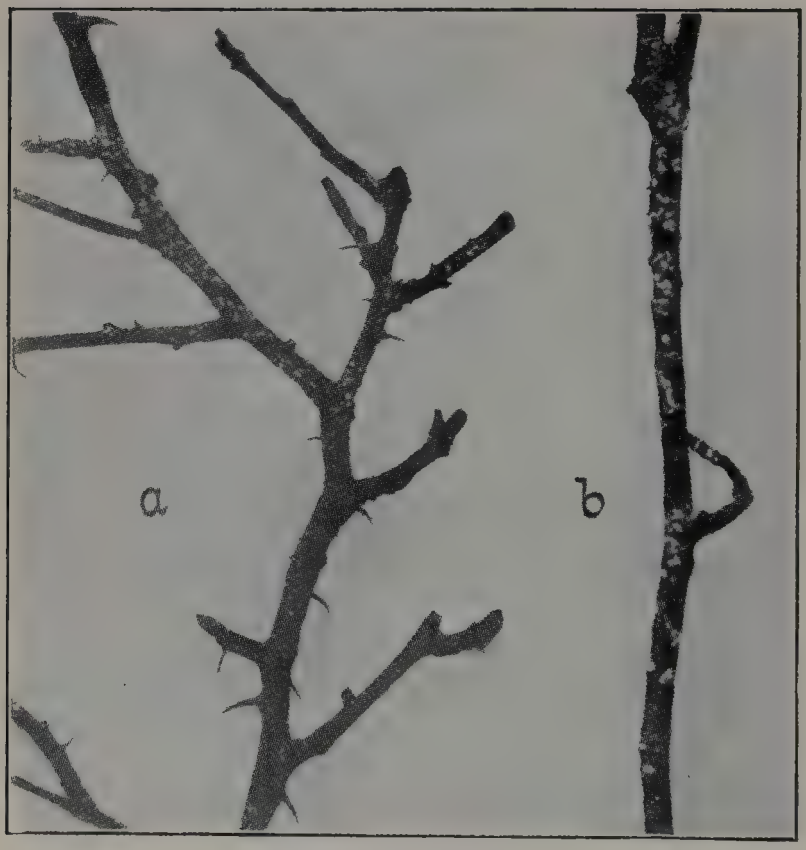


ILLUSTRATION 6.

THE ROSE SCALE. (*a*) on old; (*b*) on young wood.

Newstead, one of the chief authorities on scale insects, says it occurs freely on wild Roses in hedgerows and sheltered places in many parts of England. No personal observations have been made on it in the open in Kent, Surrey, or Sussex, but some bad attacks have been seen under glass. In Devonshire I have had it reported as very harmful, and at Budleigh Salterton I found it killing standards, owing to its great and rapid increase. I also found it in abundance or brambles near Babbacombe Bay, in Devon. It also occurred on " ramblers " and Gloire de Dijon up a house in such numbers that they were gradually dying back. The standards had even the buds attacked at Budleigh Salterton.

Newstead says this scale insect will attack the leaves under glass and, in warmer climates than Britain, in the open. The disease can easily be told by comparing it with the photo reproduced here, the curious white scurvy-like patches being very marked (see illustration 6).

LIFE HISTORY AND HABITS.

The female " scale " is at first pure white, with a small yellow speck near the margin—the cast larval skin. In form, the " scale " is rounded and flat and rather thick. The female is deep red to crimson, as also are the ova and the active six-legged young. The male of this coccid is often nearly as common as the female. The male scale is very small and elongated.

It is white in colour in its young stage. The adult males hatch out in May and June and are bright coloured. The females lay their eggs in August, and the orange larvæ crawl out very soon from beneath the scales and wander over the bushes. At this time a badly attacked bush looks as if dusted with red powder. The young larvæ soon settle down and gradually the scaly covering is formed, and they either turn to the almost structureless female beneath or become the male puparia. Out of doors there is only one brood or generation, but I fancy under glass there are several broods during the year.

PREVENTION AND TREATMENT.

As this pest is frequently taken into gardens on briars it is very important to discard any which show the least trace of it. Still better would it be to have *all* briars disinfected. The simplest method of destroying this pest is to wash the stem and branches, etc., with paraffin emulsion in February. But the use of paraffin should be avoided if possible, and I believe that spraying several times with soft-soap and nicotine wash when the larvæ are appearing in August will prove quite as effectual. The Golden-crested Wren was found to prey upon this pest in Devon.

The Brown Scale *(Lecanium persicæ)*.

Numerous enquiries have reached me concerning this brown scale insect on Roses under glass. A most

destructive insect and not easy to deal with. It feeds on many plants, such as vines, plums, figs, apples, spiræa, robinia, peach, nuts (*Corylus*), &c. The adult female is dusky yellow and gradually darkens, paler in the middle, with eight or nine transverse bands and confluent spots. In form it is hemispherical. The female at the period of reproduction is shiny reddish-brown. Eggs are laid when the insect is under glass in May, and the larvæ hatch in mid-June and wander about. A single female may lay very many eggs. The male insect is unknown in this country.

The larvæ are pale red or yellow at first, becoming greenish or pale reddish, and emit long fine glass-like filaments from both ends. They pass the winter as full fed larvæ, scarcely visible to the naked eye, and moult in spring and then grow rapidly.

The only treatment is when the leaves are off to spray with paraffin jelly, otherwise hand treatment must be resorted to.

The Willow Brown Scale *(Lecanium capreæ)*.

This Scale Insect lives on many trees and bushes, including willows, apples, elms, sycamores, hazel, euonymus and wild and cultivated Roses. It is subject to much variation. The old adult female is spherical in form and is a quarter to one-fifth of an inch long, rather less in breadth and of a dusky chestnut

brown. The female lays, according to Newstead, about 2,000 eggs. The eggs are pale yellow and look like fine dust under the dead body of the female ; they hatch at the end of the summer into pink larvæ, which soon become orange and crimson or reddish-brown. These young remain on the plants all the winter as small, elongated brown bodies about one-twelfth of an inch long. The male scale insect is different and the adult male is a pale crimson colour, with two broad short wings and two long tail filaments. These males occur in April and May. By the time the males are ready to hatch, the females are mature and the males fertilise them. This Scale Insect may occur on all kinds of Roses, but is only abundant on those that are neglected. They may be destroyed in the same way as the former species.

Mealy Bugs *(Dactylopius citri and D. longispinus)*.

The two Mealy Bugs, *Dactylopius citri* and *D. longispinus* attack many plants under glass and in stove houses ; they are particularly harmful to vines stephanotis and camellias in this country. It is no uncommon thing to find Mealy Bugs infesting Roses under glass and then if neglected they may do much harm. These Scale Insects, which although sluggish are free moving creatures, are not provided with any scaly covering, nor do their bodies harden as in the Brown Scale Insects. The difference between the two species of Mealy Bugs is that *Dactylopius citri* has short body processes and *D. longispinus* has very long

ones. The Mealy Bugs shelter in crevices, at the axils of buds, etc., and are covered with white meal and wool. The mature females vary from one-twelfth to one-eighth of an inch long ; these females are wingless. The males are very delicate creatures and have two wings which are irridescent blue and the body has two long tail filaments. Under glass they may breed all the year round. Rarely Mealy Bugs occur in the open in sheltered places. The females lay great numbers of eggs, which soon hatch into little larvæ, the so-called " spawn."

When seen on Roses the White Mealy spots should be painted with methylated spirits ; in this way they may easily be controlled on a few Roses. They are usually worst on Roses trained up walls, etc., of glass-houses.

Frog-Hopper or Cuckoo-Spit Insect *(Philaenus spumarius)*.

The curious frothy white substance so frequently seen on Roses, which is popularly called cuckoo-spit, is caused by an insect—one of the Cercopidæ or Frog-flies, known as *Philaenus spumarius* (Plates I., Fig. 7, and V., Figs. 3 and 3a).

There are a number of these " frog-flies " found in Britain. One occurs on alders (*Aphrophora alni*), another on willows (*A. salicis*). Of the four Philaenas three occur on low plants and herbage. The only

one found on the Rose by myself and sent by correspondents is the one mentioned here.

If we remove the frothy substance we find living in the moisture a yellowish creature, which is rather active. This is the young frog-hopper, the larva first and then the nymph.

It is found on other plants than the Rose, for instance it occurs in large numbers on hawthorn hedges, and it also attacks the apple ; carnations often suffer severely.

The damage to Roses in some years is very great. The insects take up their abode at the base of the blossoms before they open, and kill or deform them by the constant sucking of the sap. The result is the buds may die and turn brown or become deformed and stunted. Others are found at the base of the leaves and on the young shoots. The leaves fade and the whole shoots die away when several insects occur close together.

The attack is usually worst in June, and is apparently not confined to any particular kinds of Roses in bad years. Roses trained against a wall, pergola, or fence, however, seem to be more attacked than bushes or standards in the open, and ramblers seem to be particularly susceptible to attack.

LIFE HISTORY AND HABITS.

The adult " frog-hoppers " may be found from July to October. Their curious form is shown in the figures (Plates I., Fig. 7., and V., Fig 3). The colour is extremely variable, as many as thirteen varieties being known. The commonest form is figured here, but some are uni-colourous yellow, and some black. This species can always be told by the sides of the front wings being distinctly rounded. The length varies from one-fifth to one-fourth of an inch. Like the preceding insects they have a sucking mouth, by means of which they draw out the sap. They can jump quite a considerable distance, and may be found in the summer on to October settled on various plants.

The " frog-hoppers " have a larval and pupal stage, both of which are unable to hop and which produce the frothy-looking substance beneath which they live. These two stages are pale yellowish and are collectively called nymphs. The latter stages are told by having small lateral wing buds. The winged adults are said to hibernate and lay their eggs on the plants in the following spring. The adults do not appear to do any harm.

TREATMENT.

Nothing but spraying will do any good, unless we have the patience to go over all our bushes and

hand pick them. As I said before, the paraffin emulsion is dangerous to use on Roses and is not nearly as effectual as nicotine for this pest. Experiments conducted the last few years have shown that nicotine or tobacco wash will kill the larvæ or nymphs wherever the spray hits the frothy masses, and this is advised as it does not harm the bushes.

The nicotine and tobacco washes are referred to in the last section.

The Rose Leaf-Hopper *(Typhlocyba rosæ)*.

Rose leaves are frequently noticed in the summer to become pale and mottled, or almost marbled (Plate V., Fig. 8a). On examining the leaves there will be found beneath them one or more dried grey insect skins; these are the cast skins of the Rose Leaf-hopper (*Typhlocyba rosæ*), an insect which belongs to the same group of Hemiptera as the preceding pest. In warm, dry weather in summer the damage they do is often very marked and causes the leaves to fall prematurely, and so prevents the proper maturing of the wood.

This insect has pale yellowish or dull white wings; the head and thorax are also whitish, and the abdomen also yellow. In length it is one-seventh to one-sixth of an inch (Plate V., Fig. 8).

LIFE HISTORY AND HABITS.

These little insects feed upon the leaves, usually on the under sides, and may be found first in May on the Roses. They take flying leaps into the air when disturbed, the movement being conducted by means of their longish hind legs. The females place their eggs just under the skin of the leaf, up to four being laid in the leaf together. On the young hoppers hatching they force their way out and feed on the under surface. These young or larvæ are pale yellowish, and before each moult they fix themselves firmly on to the leaf by means of their proboscis—so firmly that when the skin is cast it remains attached to the leaf. The next stage is the pupal stage, an active stage the same as we see occurs in the aphis. The pupa has wing-buds, and like the larva feeds beneath the leaf. These two stages (nymphs) are often found side by side, and they do endless harm. Five moults take place before the nymph is matured and ready to change from a crawling into a hopping flying creature. The second brood appear in September and lay eggs. These hatch into larvæ. Winter is passed in larval, pupal and adult stages; the latter is unusual, however, but in 1924 I found many on Roses as late as mid-November.

TREATMENT.

The young, when noticed on the leaves, may be killed by nicotine wash. The adults may be jarred

off the bushes on to tarred boards, or knocked off by a heavy spray of water on to the ground and there killed mechanically, or by spraying with a *strong* nicotine and soft soap wash.

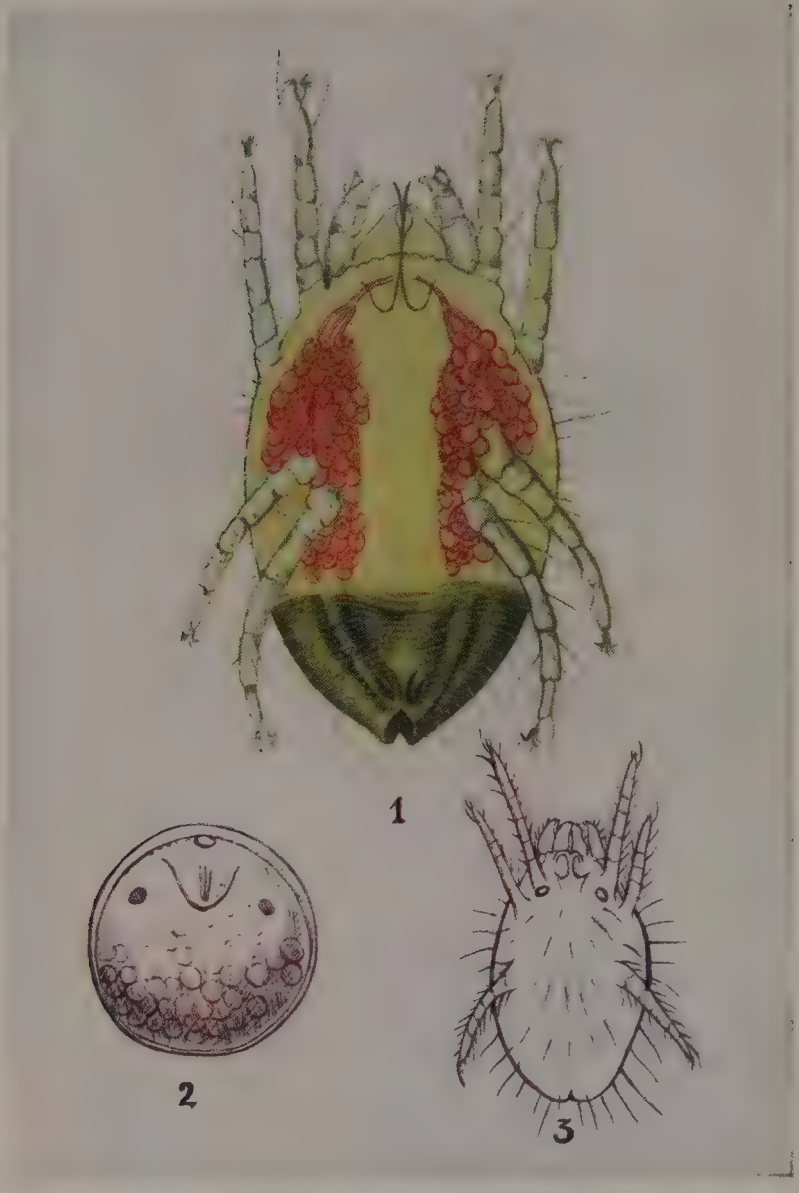
Thrips *(Thysanoptera)*.

The black fly, thunder fly or thrips is often found doing damage on Roses. The species is known as *Thrips vulgatissima.* Thrips are all small insects, the Rose pest being only one-twelfth of an inch long. They have four narrow wings, edged with long fine hairs. The body of the adult is black and the legs pale. The larvæ are wingless and yellow to reddish yellow, with the head, part of the thorax and the apex of the body black. The nymphs are very similar but brighter. The females lay their eggs in the leaves, and the adults and larvæ feed upon the foliage and even blossoms. The effect they produce on the leaves is very similar to that caused by leaf-hoppers, namely, a pale mottling of the surface.

TREATMENT.

The best treatment for thrips is copious syringing with cold water, but when the attack becomes very bad nicotine or tobacco wash must be used.

Under glass fumigation with tobacco paper or cloth, repeated two or three times, is the best plan.



1. RED SPIDER (*Tetranychus telarius*).
2. EGG.
3. SIX-LEGGED LARVA.

(All greatly enlarged.)

Red Spider *(Tetranychus telarius).*

Many requests have been received for information of damage done by red spider on Roses out of doors. Under glass the well-known *Tetranychus telarius* often becomes troublesome. This acarus—a mere moving speck—varies in colour ; some are dull green, some semi-translucent, others red. (Plate VI.)

They can at once be told from any of the insect pests by having when mature eight legs. They live on the leaves, usually the under surface, in colonies and spin a fine silken web, beneath which they lay their round eggs (Plate VI., Fig. *c*). The young are six legged, but otherwise like the parents (Fig. *b*). The result of their working is that they cause first a marbling of the leaf, then it turns yellow and dies.

Under glass they may keep on breeding all the year through. The red spider attacks many other plants, such as vines, peaches, camellias, etc. Red spiders breathe through their skin, and they are protected by their webbing in the case of the Tetranychus. In consequence they are very difficult to destroy.

Two species are recorded from Roses, one the common *Tetranychus telarius,* which attacks so many kinds of plants and which on hops has been called *T. althaeæ* and (2) *Paratetranychus pilorus,* a more hairy species, but I have never seen this species on Roses.

TREATMENT.

Out of doors there is no better plan than two or three sprayings with liver of sulphur at an interval of a few days, best perhaps at ten days' interval. One of the best ways of applying liver of sulphur is to mix it with flour paste ; this holds it on to the leaves. The wash is made by making half a pound of good strong wheat flour into an ordinary paste, just as bill sticker's paste is made, and then mixing it with five gallons of water. To this paste-wash the liver of sulphur is added after having been dissolved. The flour paste wash alone will destroy a very large percentage of the acari by blocking up their webbing and also the skin of the mites it comes in contact with. It does no harm and is a very cheap wash, but it forms a rather shiny layer on the foliage.

In a greenhouse, so far, we can recommend no better plan than painting the pipes with flowers of sulphur mixed up into a paint. The heat, however, must not be great, or the fumes may come off too strong and do damage. A small amount of heat and the treatment carried on for three or four times will soon clean a house of this pest, for we must remember the fumes will not harm the eggs, and thus we must repeat them to kill those that hatch out some days (4—8) later. Frequent spraying with cold water also does much good.

WASHES USED FOR ROSE TREES.

Amongst the various methods of coping with insect attacks, the spraying or washing of the plants with some insecticide or fungicide has year by year become more popular. When we have to deal with a delicate plant like the Rose we must proceed with great caution, as any caustic substance is very likely to do more harm than the pests themselves.

For this reason we wish to discourage the use, in any form, of paraffin as an insecticide, and it is only advised as such in very exceptional circumstances, such as very bad attacks of Scale Insects.

The washes of greatest benefit for Rose pests are : (1) Soft soap and quassia ; (2) Nicotine ; (3) Tobacco washes with soft soap ; (4) Hellebore wash; (5) Arsenate of lead ; (6) Liver of sulphur ; (7) Paraffin jelly.

(1) *Soft-soap and Quassia Wash.*—This or nicotine are by far the best for Aphis or Green fly, and young scale insects.

The quantities to use for Roses are as follows :—

Soft soap	½-lb.
Quassia	1-lb.
Water	10 gallons.

The quassia chips are steeped in cold water or just allowed to simmer and then the extract is poured off

into the soft soap solution. The quassia chips may be steeped several times as the quassine is only extracted gradually.

(2) *Nicotine Wash.*—This is especially useful for thrips, leaf-hoppers, and cuckoo-spit, but also kills Aphis and young Rose maggot and sawfly larvæ. The quantities are :—

Nicotine (90 p.c.)	¾-oz. to 1-oz.
Soft soap	2-ozs.
Water	10 gallons.

The soft soap is first dissolved in warm water and then when cool the nicotine is stirred into it.

(3) *Tobacco Wash.*—This is as good as nicotine, but more trouble to make :—

Tobacco	½-lb.
Soft soap	1-lb.
Water (soft)	12 gallons.

Steep the tobacco in water for some days and then allow it to simmer over a fire for an hour ; pour off the liquid, well squash and proceed again as before, and add the second extract to the first. This extract may then be mixed with the dissolved soft soap.

Spencer Pickering recommends 1½-oz. pure nicotine to 10 gallons of water. I have found the ¾-oz. of nicotine, 2-ozs. of soft soap to 10 gallons quite sufficient for thrips, green fly, and 1-oz. to 10 gallons

for the Rose maggots. The addition of the soap allows a decrease in the quantity of nicotine and also increases the adhesive power. Various patent nicotine preparations can be bought.

(4) *Hellebore Wash.*—This wash has been much used for sawflies. Hellebore is used as a fine powder to dust over these insects, but it is far best, especially for Roses, used as a spray. It is made as follows :—

1-oz. of fresh ground hellebore.
2-oz. of flour.
3 gallons of water.

The hellebore and flour are mixed together with a little water and then mixed with the rest of the three gallons. It must be constantly stirred and sent out as a fine spray. Nicotine wash is just as good and kills many other insects than sawfly at the same time.

(5) *Arsenate of Lead.*—The method of mixing is as follows :—

Arsenate of soda	3½-oz.
Acetate of lead	7-oz.
Water	10 gallons.

The arsenate and acetate are each dissolved separately in 5 gallons of water and the solutions then mixed together. This wash is best obtained ready made in paste form.

(6) *Liver of Sulphur Wash.*—Sometimes useful in attacks of red spider, and has fungicidal properties.

For Roses no more than 1-oz. should be used to 10 gallons of water. It is best used with flour paste as previously mentioned.

(6) *Paraffin Jelly.*

Paraffin	5 gallons.
Soft soap	8-lbs.
Water	10 gallons.

The soft soap is boiled in a copper with about 1 gallon of water and to this is added a few pints of cold water to make up for evaporation. Put out the fire and whilst the soap is hot add the paraffin and well mix with a force pump and by degrees add more water up to 10 gallons. When thoroughly mixed pour this off into pails or barrels and it hardens into a jelly which will keep a long time. Use 10-lbs. of this jelly to every 40 gallons of warm water.

SPRAYING.

The spray fluids used for the control of Rose pests have been previously mentioned.

The main thing in spraying is to see that it is thoroughly well done or it will only be a disappointment. Much depends as to whether we are spraying for insect or fungus pest and for what particular kind of pest. If one is spraying for Aphis, Leaf Hoppers, Cuckoo Spit or Rose Maggots a heavy washing until the leaves drip is essential, so that the contact

wash reaches every part of the bush. If we have to use a stomach poison, such as Arsenate of Lead, when any particular caterpillar is very abundant, such as Winter Moth, Lackeys or the Brown Tail, then we must send over the bushes a very fine mist, with the object of its forming an even coating over the foliage, so that the caterpillars may eat a maximum amount of the poison. The same applies to the fungicide Bordeaux Mixture, for a fine layer must be formed over the leaf so as to kill and prevent any increase of the fungus, for Bordeaux Mixture is a preventive as well as a killing agent. If such washes are put on too thickly they run off the leaves, and where the drops collect at the edges scorching may take place. Liver of Sulphur, whether used as a fungicide or insecticide for Red Spider or Scale, must be used in the same way. The different grades of spray can be varied by using different nozzles to the spraying machines. Two nozzles are usually sufficient for garden work—a very fine one and a moderate bore one. Any washes used, if home made, must be accurately mixed or more harm than good may be done by them. Practically all the insecticides and fungicides mentioned in this book can be made at home, but great care must be taken in mixing Bordeaux, Arsenate of Lead and any paraffin emulsion. Many people prefer to buy some ready made wash, and there are many good ones on the market; the Rose grower must carefully choose one of these for himself. As a matter of fact the writer is very strongly opposed to any

combined insecticide and fungicide wash, as he has noticed so many failures in this respect. But, speaking generally, you can use Bordeaux and Arsenate of Lead, but it appears to the writer that even then the effect of the latter is not so good as when used alone. You can also use Nicotine with Bordeaux but not soap; if you do not use soap with the Nicotine it is certainly not so effective.

One must definitely bear in mind that it is of little value to syringe Rose bushes with an ordinary garden syringe, for not only is a great deal of the spray fluid wasted, but much of the bush, unless absolutely drenched, is not hit, and so the insect or fungus is not properly controlled. There are two kinds of sprayers used for garden work: (1) The hand syringe, fitted with proper nozzles; and (2) the Knapsack Sprayer.

The former is quite sufficient for small gardens, but where a large breadth of Roses are grown the Knapsack must be employed. In both cases it is essential that the nozzle is bent, so that one can direct the spray fluid under the leaves as well as above.

There are several very good hand syringes on the market adapted to this work, and the Rose grower is advised to try them first to make sure which suits him best.

Of Knapsack Sprayers there are two main types, the most general being one worked by a handle which pumps the spray fluid out. The second now often used is a high pressure sprayer; this saves a good deal of energy when spraying. The spray fluid is put into the receiver and then air is forced into it to a very high pressure by means of a force pump attached. The spray is released by simply turning a tap when it is on the user's back, and the fluid is spread out under a good pressure as long as sufficient air pressure remains in the receiver. A gauge is attached to show when sufficient air has been pumped in. If the proper amount is not exceeded and the machine is properly closed and of good sound make there is no danger from these machines, and they are certainly very convenient to work with.

Spraying machines must be carefully looked after, or they will soon get out of working order. They must be kept perfectly clean and all moveable parts must be oiled. When any one spraying has been completed the residue must not only be emptied out but must be cleaned with a good supply of water so that the parts from the receiver or tank to the nozzle are washed clear of any residue of the spray fluid. This is especially necessary after using the Bordeaux Mixture or Liver of Sulphur. It is well to see that the strainer of the Knapsack Sprayer is intact, so as to be sure that no small particles of sticks, leaves or dirt may get through and so block up the nozzle or

clog the valves. When the machine is put away for some time the joints should be loosened so as to allow the leather washers free play, or they will perish; this will happen if they are screwed up too tightly. The plunger also wants attention; if of leather it should be well oiled with neatsfoot oil and should always be kept oiled.

No matter which of the spray fluids recommended in this book is used, one must bear in mind certain cardinal facts mentioned below.

Never spray in hot sunshine; if one does do so a certain amount of scorching is sure to result; this may even happen with plain water.

Never spray on a cold clear evening, or chilling may produce a similar effect to frost.

Never spray fully opening blossoms with any wash, especially if wanted for show purposes—even Nicotine and Soft Soap may cause slight staining.

Never use a spray fluid unless it is properly and well mixed, especially if paraffin in any form is used.

Never leave poisonous spray fluids standing about in vessels where animals may get at them or leave them in unlabelled casks, tins or bottles; this especially applies to Bordeaux, Arsenate of Lead and

Nicotine. The writer once saw pure Nicotine left in mineral water bottles ; any child might have taken it and there was enough to have poisoned dozens of people. Put a red label on the bottles, etc.—*Poison*—and keep under lock and key.

The number of spray applications varies with the season and pests to be dealt with. It is usually advisable to spray soon after pruning with Nicotine and Bordeaux, and the ground beneath the bushes should also be sprayed. Winter spraying is seldom necessary, but if this is done Lime Sulphur wash is best to clean the wood. This wash is best bought ready made. Except for Aphides, Cuckoo Spit and Tortrix or Rose Grubs a fine spray is best, no matter whether for insects or fungus. A dense mist-like spray will penetrate almost anywhere, whereas a heavy washing will mostly run off and often not touch the under parts of the foliage, even with an upwardly directed nozzle. For Aphides several sprayings are usually necessary, a look-out being kept for the advent of fresh winged females, which should be at once attacked.

ROSE DISEASES CAUSED BY FUNGI.

By John Ramsbottom, O.B.E., M.A., Sec. L.S.

INTRODUCTION: Health and Disease.

In studying disease of any kind it is well to begin by considering what is health. Health, in general, means that the organs and tissues of an organism are able satisfactorily to perform their normal functions. When, however, we reduce this to its final terms we find that health in wild plants has to be regarded somewhat differently from health in cultivated plants. The criterion of health in a wild Rose, for example, growing under natural conditions, is fitness to survive in the struggle with its complex environment, and the ability to produce viable seeds which are able to carry on the race. Do we apply this criterion to cultivated Roses? Perfection in the horticultural sense is widely different from perfection in the wild state, just as human perfection under present day conditions is radically different from what might have been so described in neolithic times. A Rose-grower sets himself ideals for his plants—and these ideals change with the years. If his plants were to be put under natural conditions is it likely that more than a very small proportion of them, if any, would survive? From this point of view we are dealing from the start

with unhealthy plants, plants which by their very constitution are unable to resist the trials and struggles of unpampered existence. But a grower of Roses is not concerned with what would happen to his plants under certain theoretical conditions, except, perhaps, as he may muse as to how he might overcome some palæolithic monster with the hunting weapons of the period. He is dealing with plants in garden or greenhouse, and has his standards of perfection, some artificial, many natural. A cultivated Rose may be said to be healthy from the grower's point of view when it reaches these natural standards of perfection; the other standards, such as flower colour, overgrown habit and so on, do not enter into such considerations. If it fail in these natural standards it is said to be unhealthy or diseased.

It is possible to consider disease for our present purpose as being due to (1) the innate characters of the plant; (2) environmental conditions; (3) parasitic organisms.

Concerning the first of these we need not delay. It is obvious to every grower that at times a plant occurs, usually a seedling, which no sort of culture appears to suit; it is constitutionally unfit to exist.

The second is important culturally. Roses require certain treatment of the soil, certain temperature, moisture, sunlight and air in order to reach the state to which it is desired to bring them. It is important

to realise that if cultural conditions are bad parasitic organisms are benefited in every way.

To understand the problems which have to be faced in dealing with parasitic disease it is necessary to have some idea of the life histories, both of the organism attacked and the attacking organism, i.e., the " host " and the " parasite." The principle is the same, no matter whether the host is man or Rose.

So far as fungi are concerned there does not appear to be any species known only on cultivated Roses, with the possible exception of the downy mildew (*Peronospora sparsa*). All occur on wild Roses, though fortunately not all those known to occur on uncultivated forms have, so far as is known, penetrated into cultivation. It should be said, however, that considering various circumstances, cultivated Roses are remarkably free from disease; it would be expected *a priori* that highly nurtured Roses would be more seriously affected by the natural enemies of the genus than wild species which have always been liable to attack and presumably have acquired a certain degree of immunity, even granting the fact that cultivated Roses receive special treatment.

NATURE OF FUNGI.

To the uninitiated it always comes as a matter of surprise to learn that fungi are plants. The essential character of plants to most people is the possession

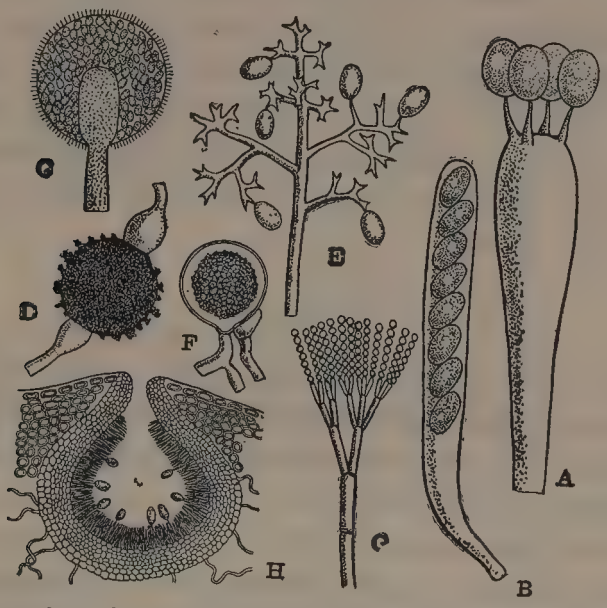
of the green colour which prevails in fields and woods. This green colour, which is due to what is known as *chlorophyll* (leaf-green), is absolutely necessary to plant life and thus to all life as we know it. By its aid an ordinary plant is able to build up organic food (carbohydrates) from the inorganic substances carbon-dioxide and water. Light is necessary and also a certain temperature. Fungi, like animals, not having chlorophyll, cannot make use of inorganic substances and must feed on organic materials. The ordinary diet of animals is known to everyone: that of fungi is very similar. Fungi attacking other organisms for food are known as *parasites,* those living on dead or decaying organic substances are called *saprophytes.*

Fungi are cryptogams and consequently do not produce seeds but spores. The spores of fungi are always microscopic in size and are usually produced in myriads. When regard is paid to the way in which weeds appear even in a well kept garden one ceases to wonder that fungus spores reach the plants they attack. When a spore germinates it puts forth a germ-tube which grows out as a thread, or *hypha,* which by further growth and anastomosis often forms a *mycelium,* or, as it is called in the mushroom, "spawn." It is by means of its hyphæ that a parasite fungus is able to absorb nutriment from its host plant.

CLASSIFICATION OF FUNGI.

In order to understand certain facts about fungous

diseases, it is necessary to have some acquaintance with the classification of fungi. Fungi are classified according to the way in which their spores arise.



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SPORE FORMS : A, BASIDIOMYCETE. B, ASCOMYCETE. C, D, E, F, PHYCOMYCETE. C, ASEXUAL. D, SEXUAL (*Zygomycete*). E, ASEXUAL. D, SEXUAL (*Oomycete*). G, H, FUNGI IMPERFECTI (G, *Hyphomycete*; H, *Sphæropsid*).

Basidiomycetes.

Mushrooms and toadstools, fairy clubs, bracket fungi and so on, have their spores borne on the outside of structures known as basidia. A *basidium* (A) almost always has four spores and is normally more or less club shaped. The basidia are to be found on gills, on spines, lining tubes, etc., or may

be enclosed within the fruit-body until maturity, as in puffballs. In certain genera such as the Jew's Ear (*Hirneola*) the basidium has three cross walls and each of the four segments bears a spore. A similar structure results when the winter spore (*teleutospore*) of a rust germinates and consequently the two structures are homologised and the rust fungi (Uredineæ) and their close relations the smuts (Ustilagineæ) are usually regarded as highly specialised groups of the Basidiomycetes.

Ascomycetes.

The cup fungi, morels, helvellas, truffles and their allies have their spores formed inside structures known as asci. An *ascus*, with comparatively few exceptions, contains eight spores (B). The asci may be arranged on the inner surface of cup-shaped fruit-bodies. This is the characteristic of the group *Discomycetes*. In other cases the asci are borne in flask-shaped structures (*perithecia*) which, when mature, open to the exterior by a pore, which in some cases occurs at the end of a comparatively long neck. Such fungi are classed as *Pyrenomycetes*. In certain genera the perithecia are buried in a hard mass of fungal tissue known as a *stroma* (e.g., *Diaporthe*). The asci may occur, usually in small numbers, in fruit bodies which are completely closed and which must rupture for the liberation of the ascospores. This is what we find in the Erysiphaceæ to which group the common Rose mildew (*Sphærotheca*) belongs.

Conidial Stages and Fungi Imperfecti.

In going through the following pages it will be found that certain of the diseases are caused by fungi which have two or more spores in their life-cycle. The stage which includes the basidium, or the ascus, is known as the perfect or sexual stage, as it results from some form of sexual process. It is also sometimes spoken of in Ascomycetes as the " winter stage," because it is usually a resistant fruit-body able to carry over until the spring, when as a rule the ascospores germinate ; indeed, some of them will not germinate at all until after a period of rest. The mycelium of a fungus is, however, usually able to form other spores which have many special names, but for which the general term *conidium* may be used. Since conidia are usually produced in large numbers and are capable of immediate germination they serve to extend the ravages of the fungal disease during the growing season. For this reason they are often popularly called " summer spores." Sometimes these spores are just budded off from hyphæ (e.g., the *Oidium* stage of *Sphærotheca*) ; at other times they are borne in flask-shaped structures (*pycnidia*) resembling the perithecia of Pyrenomycetes, except that the spores are budded off from hyphæ and are not borne in asci. Such structures are seen in *Coniothyrium, Septoria,* etc. When these asexual stages are known to belong to the life-cycle of one of the higher fungi, they are so treated, but at times we have no clue to these associations and we class the stage

amongst the *Fungi Imperfecti*—fungi of which the knowledge of the life cycle is incomplete. A rough classification of such forms would divide them into *Hyphomycetes*, where the spores are borne freely on hyphæ (G) and *Sphæropsideæ* where they arise within pycnidia (H).

Phycomycetes.

A third main group contains such fungi as bread mould, salmon disease and potato disease. There is never a compact fruit-body formed but the whole fungus is filamentous, much like that of green algæ. Two stages are usually present, and the sexual stage, which results in a somewhat large resting spore, is formed after a quite obvious sexual union. *Peronospora*, which is the only fungus we have to deal with, belongs to the *Oomycetes*, where the sexual organs are differentiated into male and female, and where the spores are borne on hyphæ (E and F). The other group, *Zygomycetes*, has undifferentiated fusing segments and an indefinite number of spores contained in a closed sporangium (C and D).

BACTERIA.

Bacteria resemble fungi in having no chlorophyll; in fact they are regarded by many as the simplest forms of fungi, though it is more convenient to treat them as a separate group. Most human disease is due to the activities of pathogenic species.

At one time it was considered that bacteria played little part in bringing about plant diseases, but within the last twenty years they have been shown to be relatively far more important. Bacteria are always minute, and are generally either spherical, rod-shaped, or spiral. Frequently they are motile, their movements being due to flagellæ. The usual mode of reproduction is by direct division (fission) of the mother cell.

TREATMENT.

The general ideas gained from a consideration of human diseases have often given a practical man a useful standpoint from which to regard his plants. The relation between host and parasite can always be visualized as a struggle between the two. A loss of " tone " on the part of the host will always bring down the scales against it. Since childhood we have all known the adage, " Prevention is better than cure," and well-advised precautions can often be taken which prevent plant diseases to a great extent. Owing to the fact that the cells of plants are surrounded by cellulose walls, and there is consequently nothing analogous to the blood circulation of animals, we cannot apply therapeutic methods such as vaccination and inoculation. What steps is it possible to take to prevent fungal diseases of Roses as far as possible? As in all questions of health sanitation plays a prominent part.

Let us consider for a moment how a Rose disease spreads. Spores of the fungus alight on the leaves of the Rose, germinate, and, in most cases, the tissues are permeated with its hyphæ. The leaf does not at first show signs of the attack: there is an incubation period during which the fungus is absorbing nutriment. A yellow or brown patch is then seen on the surface of the leaf, indicating that all is not well, and later the spore-bearing fruit-body of the fungus bursts to the surface. Vast numbers of spores are produced, and are scattered far and wide by wind, rain, insects, clothing and so on. If they liberally infect neighbouring Roses an epidemic is the result. It is clear that the point at which to aim is the prevention of infection.

How does the first infection of spring or summer come about? It may be that spores are transported from a neighbour's garden or from wild Roses growing in the neighbourhood, but it is more often from spores on diseased leaves of the previous year. These should, therefore, be carefully collected and burned, together with any remaining on infected bushes. A source of infection in one's own garden is naturally the most dangerous. The matter is complicated by the fact that in many diseases the mycelium of the fungus continues to live in the tissues of the wood, and the disease shows itself again the following year without re-infection. The surgical operation of cutting out the diseased wood is the

obvious method of eliminating the trouble, but ordinary precautions of sterilisation should be adopted in doing so.

No matter how clean a garden is kept, however, it is vain to expect Roses to remain free from infection. Consequently spraying with various chemicals must be resorted to. This is a prophylactic method. It is useless to spray with the idea of killing the mycelium of a fungus entrenched within the tissues of a leaf; a diseased leaf remains diseased, but the portions of the fungus on the surface, particularly the spores, are killed, and infection of neighbouring leaves is prevented both in this way and from the fact that the substance deposited on the leaves acts as a poison to any spores that may alight on them. It is much the simpler matter to spray Roses before the period at which the disease usually makes its appearance. The point to be grasped is that any poisonous substance is only efficacious so long as it remains on the plant; if a shower of rain occurs the protection afforded by a previous spraying is immediately nullified.

SPRAYING.

From what has been said above it will be realised that the object of most spraying with fungicides is not the cure of disease but the prevention of further infection. All the fungi causing diseases of Roses, with the exception of the common mildew, have their mycelium buried in the tissues, and consequently

protected from any solution which could harm them without seriously damaging the host plant. For superficial mycelium sulphur in some form or other is the most effective. In all cases the principal object of spraying is to prevent the germination of the spores with their production of a germ-tube which could attack the host. The general idea underlying the application of sprays is to produce an enduring film in which a poisonous substance is gradually set free in such a way as not to affect the tender tissues of the host but which shall prevent the successful germination of the spores.

Bordeaux Mixture has been the standard protective fungicide since the year 1885. It has been shown that the germinating spore will absorb from the nearly insoluble compounds sufficient toxic substances to kill it. What is often known as the standard solution is composed of :—

Copper sulphate (blue stone) ...	5 lbs.
Stone lime	5 lbs.
Water	50 gallons.*

A mixture of this strength is often known as the 5—5—50 formula, and any variation is indicated by altering the figures of copper sulphate and lime

* The quantities given for the preparation of the different sprays, etc., are those most frequently used. A simple calculation will give the relative proportions of the constituents for the amount of solution required.

respectively, e.g., 6—4—50 is a common formula. The standard formula gives an excess of lime which is advantageous in places where lime is usually very impure. The copper sulphate used should be 98 per cent. purity, the lime freshly burned stone lime of good quality. The copper sulphate is dissolved in water by suspending it just under the surface in a piece of sacking. The solution should not be placed in metal vessels. When the crystals are dissolved water is added to make up to 25 gallons. The quick lime should be slaked gradually by adding a little water and leaving it for about half an hour to crumble; further water is added to form a cream or milk, and finally more is added to bring the amount up to 25 gallons. The lime solution is then poured slowly into the copper sulphate solution and is stirred just enough to secure complete mixing. If it is inconvenient to have the two equal amounts of liquid it is better to add a weak copper solution to strong milk of lime than vice versa. The physical properties of the solution are all important, as the adhesion of the spray depends upon the precipitate. The nature of the precipitate originally formed depends to a great degree upon the method of mixing; when strong solutions of the ingredients are used a heavy precipitate results. The precipitate in freshly prepared Bordeaux mixture should be flocculent or gelatinous in appearance and of a brilliant sky-blue colour, settling very slowly when allowed to stand. The mixture should be used immediately after mixing, as in a few hours the sedi-

ment becomes more crystalline, settles quickly after shaking and loses its adhesive power. By adding a pint of milk, skimmed or whole, to every four gallons, the flocculence and adhesiveness can be preserved to some extent. Bordeaux mixture should be strained through a fine copper or brass gauze sieve before placing it in the sprayer and constantly stirred or shaken during use. When Bordeaux mixture is needed from time to time stock solutions of copper sulphate and lime (1-lb. to the gallon) can be kept and diluted to the required strength before using.

As copper sulphate has a scorching effect on foliage it is usual to test whether any remains over in the solution owing to there being insufficient lime present. A common test is to hold a bright iron nail in the mixture for a few minutes—if there is a deposit of copper on the nail more lime should be added. A more precise method is to add a little potassium ferrocyanide solution to some of the clear liquid after the Bordeaux mixture has been allowed to settle. A reddish brown colour indicates that more lime is necessary, and this should be added until no change in colour results from adding the test solution.

Woburn Bordeaux is a modification of the above, in which clear lime water is used and less copper is required.

Copper sulphate	...	...	1 lb.
Clear lime water	...	...	13½ gallons.

Soft water to make up to 76 gallons.

Dissolve 8-lbs. of copper sulphate in a gallon of water. Slake about 1-lb. of quicklime and add thirty gallons of water. Stir two or three times and allow to settle. Run off 13½ gallons of the clear lime water and mix it with the copper sulphate solution. Then add soft water to bring the whole up to 76 gallons. The liquid should be tested with potassium ferrocyanide solution. (Hard water may be softened before using by adding lime water to it.)

Burgundy Mixture is used where there is difficulty in obtaining lime, this being replaced by ordinary crystallized washing soda. It is simpler to prepare than Bordeaux mixture and there is less likelihood of sediment, which clogs the sprayers. It has, however, a greater tendency to cause scorch than has Bordeaux mixture.

Copper sulphate	4 lbs.
Crystallized sodium carbonate (washing soda)	5 lbs.
Water	40 gallons.

Burgundy mixture is best prepared in a manner similar to Bordeaux mixture. The copper sulphate and soda are each dissolved in half the amount of water, the soda solution is added to the copper solution, and stirred thoroughly the whole time; or each constituent may be dissolved in about five gallons of water and after mixing brought up to the forty

gallons. The mixture forms a bright blue liquid with a flocculent precipitate which remains in suspension for some time. Burgundy mixture must be used fresh.

Copper sulphate wash is often used as a winter wash for Roses and as a soil drench.

Copper sulphate	3 ozs.
Water	4 gallons.

It should be used only on dormant plants. It must not be applied to leaves or opening buds.

Ammoniacal Copper carbonate is not so successful as Bordeaux mixture or Burgundy mixture, but has the advantage that it does not cause disfiguring of the foliage.

Copper carbonate	5 ozs.
Strong ammonia	3 pints (·880).
Water	40 gallons.

The above is the usual formula. The copper carbonate is made into a paste with a little water; the ammonia, after being diluted to 1 gallon, is added to it in small amounts, stirring all the time. The remainder of the water is then added. The mixture loses strength with age, and should be used immediately. A stable stock solution can be made by using 8-ozs. copper carbonate, 1½ pints strong ammonia and 1 pint of water; when required for use 3 gallons of water are added to each pint of stock solution.

Cheshunt Compound is a mixture which is useful as a soil drench.

Copper sulphate, 2 parts by weight.
Ammonium carbonate, 11 parts by weight.

Fresh ammonium carbonate is powdered and mixed thoroughly with copper sulphate in the proportions given. The mixture is stored in tightly corked glass or earthenware jars for 24 hours before using. Dissolve an ounce of the mixture in a little hot water and add to two gallons of water. The compound should be used fresh.

Potassium sulphide or **Liver of sulphur** is useful for spraying against mildews. It does not cause disfigurement of the leaves, but blackens paint.

Potassium sulphide	1 oz.
Water	2 gallons.
[Soft soap	3 ozs.]

The efficacy of the mixture depends upon having pure sulphide. The solution is first liver brown in colour, but by exposure to the air it gradually becomes yellowish and then grey, with a corresponding loss of fungicidal properties. Soft soap should be added when the spray is to be used as a fungicide rather than as a preventive.

Lime sulphur wash is a useful spray against mildew.

Freshly burned stone lime ...	50 lb.
Flowers of sulphur	100 lbs.
Water	40 gallons.

The solution is somewhat troublesome to prepare, and it is best to purchase it from a reliable firm. It is made up in various strengths and the specific gravity is given. If not exposed to the air the solution keeps fairly well.

Ammonium polysulphide wash. Within recent years ammonium polysulphide wash has been recommended for use in the control of mildew, principally hop mildew. The preparation of the stock solution is too intricate for the ordinary grower. It can be purchased in two strengths, "A.P.S., 1918" and "A.P.S., 1919." A gallon of A.P.S., 1918 (or ½ gallon A.P.S., 1919) is made up to 100 gallons by dilution with water and 5-lbs. of soft soap added.

The above three washes should not be put in copper sprayers as the dissolved sulphur acts on the metal.

Dusts. The practice of dusting in place of spraying has many advocates. The dust must be in the form of an impalpable powder. The common dusts are :—

1. Flowers of sulphur.
2. Sulphur 90 parts; lead arsenate 10 parts.

PLATE VII.

MILDEW.

The dust is best applied in the early morning or in the evening.

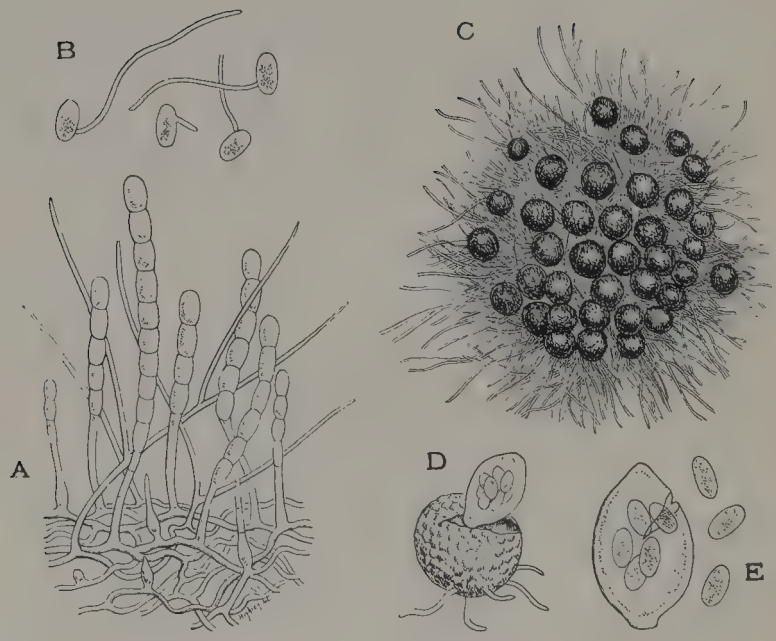
" Spreaders." In order to overcome the difficulty met with in getting leaves thoroughly wetted with a spraying solution a "spreader " is frequently added. The commonest of these is soft soap. A mixture of 2-lb. resin and 1-lb. of washing soda boiled in 1 gallon of water is frequently added to 25 gallons of Bordeaux mixture to increase its adhesiveness. Saponin at the rate of 2 ounces per 100 gallons may be added to most fungicides with advantage.

MILDEW (*Sphærotheca pannosa* Lév. var. *Rosæ* Woronichine).

Rose mildew is the most prevalent and the most destructive fungal disease of the Rose, both in the open and under glass. In certain seasons it appears in an epidemic form ; in no season is it entirely absent. The first symptom of the disease is the appearance of whitish or greyish spots on the young leaves and shoots. These spots spread and finally cover the leaf as a delicate powdery layer. All the young parts attacked are dwarfed and misshapen and many of the injured leaves fall. Often the young buds are affected and growth and flower production are seriously interfered with. When affected leaves are examined under the microscope they are found to be covered with a network of white, slender, branched, mycelial threads. On these threads are borne, here and there,

upright chains of spores (conidia) (A). These are somewhat barrel-shaped and are budded off from a basal cell. When mature the spores fall from their stalks and many lie on the leaf in masses and produce the characteristic powdery appearance. The mycelium is attached to the leaf at various points by means of minute suckers or haustoria which penetrate the epidermis as a narrow neck and enlarge within the epidermal cells, from which they are able to absorb nutriment. In some cases two or more haustoria are present in an epidermal cell, completely filling it.

The conidia as they mature are blown about by the slightest wind and are carried on to neighbouring plants, where, if the conditions of moisture and temperature be suitable, they germinate immediately by sending out a thread-like germ-tube near one end (B), which grows rapidly, soon producing a haustorium from which tender hyphæ grow out and in a few days produce a fresh crop of conidia. It should be remarked that the conidia are disseminated not only by wind but by various gardening operations, and by insects and even by snails. The conidial stage (formerly known as *Oidium leucoconium* Desm.) continues throughout the summer and early autumn. However, in *Sphærotheca* there are two kinds of spores, corresponding to an asexual stage and a sexual stage. The conidia are short-lived, retaining their vitality only for a few days, and it is to the sexual spores that the fungus owes its power of carrying on from one season to another.



Sphærotheca pannosa Lév. : A, Conidiophores with chains of conidia (*Oidium*). B, Germinating Conidia. C, Perithecia. D, Perithecium with ascus. E, Ascus with eight ascospores.

Magnification, A, B, D, 180; C, 50; E, 240.

Usually late in the summer the mycelium on the stem and emergences forms a dense satiny mass, shining white at first, but usually changing to a grey or buff colour. The hyphæ, under the microscope, are different in appearance from the ordinary vegetative hyphæ on the leaf, being densely woven, thick-walled and, at maturity, looking somewhat like glass rods. Moreover, these special hyphæ are persistent and remain on the stem throughout the winter. Immersed in these hyphæ are to be found the perithecia or sexual stage of the fungus (C). These are more or less spherical in shape and have a hard resistant wall. Within is an ascus containing eight ascospores which mature slowly (D). In the spring the ascospores are liberated by the rupture of the wall of the fruit body (E), and are able to infect any Rose leaf or young stem on which they may happen to alight. The perithecia are almost entirely confined to the stem and emergences, but occasionally are found on the petioles, the mid-ribs of the leaves, the calyx, or the fruit. It is to the asexual spores or conidia (summer spores) that the fungus owes its rapid spread throughout the growing season : the sexual spores or ascospores (winter spores) enable it to withstand the inclement conditions of winter.

Owing to the fact that in gardens the sexual stage is rarely present, an overwintering mycelium has frequently been postulated. There is, however, no convicing evidence for this. Another suggestion

is that there may be chlamydospores, thick-walled resistant spores formed within the mycelium. Under glass the temperature is probably always sufficiently high to permit of the vegetative mycelium continuing thoughout the year.

There is a great difference in the susceptibility of various Roses ranging from comparative immunity in some of the glossy-leaved Wichuraiana hybrids to great susceptibility in soft-leaved forms such as Crimson Rambler and other quickly maturing varieties. Proper aeration of the plants tends to reduce attack.

Powdery mildew of Roses is cosmopolitan, being known wherever Roses are grown. In America the hop mildew (*Sphærotheca Humuli*) commonly attacks Roses, though it has not been recorded as acting thus elsewhere.

Until recently it was considered that the mildew on peaches was the same fungus as the common mildew on Roses, but it has been found that the conidia from one host will not give rise to infection of the other : as there are also morphological differences between the fungi on the two hosts, they have been distinguished by varietal names.

TREATMENT.

A study of the life cycle of the parasite suggests the lines of attack :—

1. To prevent the appearance of, or to destroy, the ascospore stage and thus the possibility of the spring re-appearance from that source.

2. To destroy the conidial stage at its first appearance and thus prevent the production of new centres of infection. It is obvious that the two are closely connected.

The resistant perfect stage is very difficult to attack. The usual method by which such forms are dealt with is either wholly to remove them or to spray as the spores are being liberated. This stage is not very frequent in gardens. Infected branches may be cut out and burned, or, as the fungus is entirely superficial and is in no way immersed in the tissues, it may be scraped off. The proper time to do this is in late summer or autumn before the fruits rupture and liberate their spores. No matter with what care this is done one cannot hope to keep Roses free from mildew. Spores of the fungus are produced in enormous quantities and can be carried quite long distances—probably a few miles. The fungus is common on wild Roses, and in many parts of the country (in Surrey for example) the winter stage is fairly frequent on the stems.

Infection having once begun sufficient spores are formed in a few days to spread the disease to all the neighbouring plants. To prevent this

various fungicides are used. The mycelium of *Sphærotheca* and the other true mildews differs from that of almost all other diseases in being external and not buried within the tissues of the leaves. Owing to this fact sprays have a direct effect on the fungus mycelium though their chief use is not fungicidal but preventative.

SPRAYS.

Liver of sulphur, applied as soon as the leaf buds are expanded and whenever any sign of infection is observed and a week or ten days later, is the spray most frequently used out of doors. Ammoniacal copper carbonate, lime sulphur and Bordeaux mixture are also effective, and a weak solution of sulphuric acid (1 in 1,000) has also been recommended.

The method of control advocated by Russian pathologists is spraying with bicarbonate of soda, one ounce of soda to every ten gallons of water.

A spray frequently recommended is a three to four per cent. solution of the best quality soft soap. Vigorous young bushes require repeated sprayings during the summer, but one application given on a dull day or in the evening is sufficient for mature plants.

A more complicated fungicide which is said to have none of the drawbacks attending the use of powdered sulphur is made up of three solutions :

1. 3½-lbs. hyposulphite of soda to 1 gallon of hot water.

2. 3½-lbs. of bisulphate of soda to 1 gallon of hot water.

3. 2-oz. glue to 3 pints of hot water.

The glue (solution 3) is stirred with the sodium hyposulphite solution (solution 1) while still hot. This and the sodium bisulphate solution are each diluted with five gallons of water and then mixed and allowed to stand for from three to eighteen hours, when they are ready for use. By this time sulphur is precipitated as milk of sulphur. The mixture, which is slightly alkaline, may be kept for a few days, but is best used the morning following the mixing of the solutions.

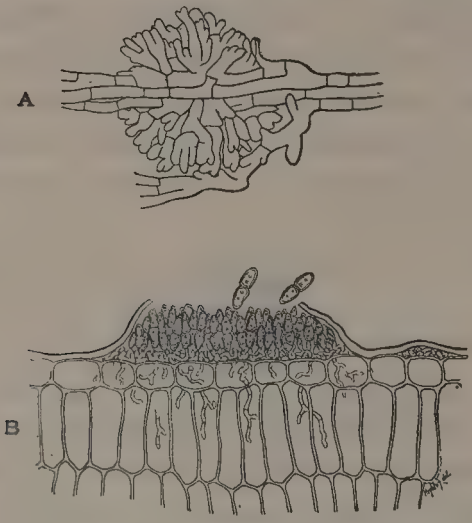
DUSTING.

Dusting with flowers of sulphur every 10 days is generally sufficient to control the disease. Dusting with sulphur and lead arsenate is regarded by some American investigators as being the most effective method of control and often causes less unsightliness in the plant than do certain spraying solutions.

In houses the heating pipes are often painted with mixtures of sulphur and lime ; the sulphur evaporates and condenses on the leaves. Evaporated sulphur is also used.

BLACK SPOT (*Actinonema Rosæ* Fr.).

This disease of the Rose is second in importance only to mildew. The time at which it appears is very variable, but it is usually noticeable about mid-summer and lasts until the coming of frosts. Leaves which are more or less fully grown are the ones most frequently attacked and show black or purplish areas on their upper surface. Some leaves show never more than infected patches, but others are soon completely invaded and are shed much earlier than healthy leaves.



Actinonema Rosæ Fr.: A, Mycelium strand within cuticle developing into spore-bed, surface view. B, Section of mature fruit-body.

Magnification, A, 400; B, 325.

After this defoliation a large crop of fresh leaves is usually formed at the end of the branches, from the

PLATE VIII.

BLACK SPOT.

buds which should remain dormant until the following season, with the result that the plant is weakened. These new leaves most frequently become attacked by mildew at a very early stage.

The spots caused by *Actinonema* are normally rounded with a very irregular fringed border and with radiating fibrils over their surface. They are often a quarter of an inch in diameter, sometimes more. After a time numerous minute, shining, black dots appear over the surface of the spots, arranged concentrically. These are the fructifications (B) of the fungus, which consist of masses of spores produced from a mat of mycelium just below the cuticle of the leaf which is first raised into a dome and is then ruptured, giving the spores access to the exterior. The spores of the fungus are hyaline or slightly greenish, two-celled, slightly curved, somewhat constricted at the septum and containing numerous oil-drops.

The spore on germination gives rise to a colourless mycelium. The cuticle of the leaf is penetrated. For the most part the mycelium is localised in the epidermal cells where it has penetrated, but it advances both laterally and vertically in young leaves, often reaching the spongy parenchyma. The mycelium changes from hyaline to yellow and then to brown as it ages. The fructifications are always formed just within the cuticle (i.e., the outermost portions of the wall) of the epidermal cells. The mycelial filaments here show a

tendency to join together laterally, forming strands. It is these strands which give rise to the appearance of radiating fibrils on the surface of the spots. Generally the fructification is formed from a single strand, principally by lateral extension (A). The colour of this mycelium darkens and gradually the darkening extends to the vegetative portions.

Transverse sections of the young fructifications show the surface of the mycelial plate or stroma to have a number of short, hyaline, conical columns arising from its surface. By their growth the cuticle is raised in a dome-like manner. The columns round off at their ends, become wider, and a wall appears across their middle, thus forming a spore. The columns (sporophores) soon take on the general tint of the stromatic layer. The spores then become uniseptate.

In addition to the subcuticular mycelium there is an extension of mycelium into the mesophyll of the leaf and the two masses are connected by hyphæ which pass either through the epidermal cells themselves, or through their walls. It is this second type of mycelium which apparently absorbs nutriment from the leaf. The dark colour of the spots is not due to the mycelium of the fungus, but to the presence in the outer portion of the epidermis of a brown substance which is a product of degeneration of the cell contents.

Until ten years ago it was generally stated that *Actinonema Rosæ* attacked only the leaves. Observation has shown, however, that in certain varieties at least, the fungus can extend to all the aerial organs of the plant—stipules, petioles, stem, sepals and petals. The fact that the stem can be affected is of considerable importance in devising means of control for the disease. So far as is known, it is only the fructifications on the previous year's wood which are of importance—the old pustules on two-years-old wood being effete.

The infected areas on the stem show a blackened, blistered appearance dotted with the fructifications. The mycelium is colourless and it develops entirely in the cortex, where it kills the tissue. Sometimes cavities are developed deep in the cortical tissue by the activity of the mycelium, and spores are produced in profusion and liberated into the cavities.

The perfect stage of the fungus has been recorded from America under the name *Diplocarpon Rosæ* Wolf. This occurs on the fallen leaves previously attacked by the conidial stage and ripens its asci in early spring. The fruit body is a shield-shaped structure, the upper part rupturing at maturity to liberate the spores. The systematic position of the perfect stage is somewhat doubtful. The conidial stage of the fungus is also known as *Marsonia Rosæ* Br. and Cav., and *Diococcum Rosæ* Bon.

TREATMENT.

All diseased leaves should be collected from the ground and from the bushes and burned. Infected wood should also be cut away. From the time of first infection to the production of a new crop of spores takes about a fortnight. It is therefore essential that the first attack should be guarded against. This can be done by spraying the young leaves with Bordeaux mixture, ammoniacal copper carbonate, or liver of sulphur. Dusting with sulphur and lead arsenate powder has also given good results.

RUST (*Phragmidium subcorticium* Wint.).

This disease, as a rule, is not of much consequence, but in certain seasons proves very troublesome. No variety of the cultivated Rose appears to be immune, and hardy hybrid varieties seem particularly susceptible. It is very abundant on wild Roses and may frequently be found on shoots growing from stocks of neglected standard Roses. It does not occur under glass.

The name " rust " was first applied to a disease of cereals caused by a fungus closely allied to *Phragmidium*. The first stage of the disease of Roses has the same characteristic rusty colour that wheat rust has. It is commonly known that the rust of wheat has three stages in its life-cycle, one of which occurs on the common barberry. The Rose rust has

Plate IX.

Rose Rust.

1 & 1a. Winter Spores. 2. Summer Spores.

the same stages in its development, but all stages occur on the Rose—there is no alternate host.

The first stage formed is the *cæoma* (A) which appears as a small pustule-like structure on the under surface of the leaf. The usual time for its appearance on the leaf is early spring. On the rupture of the epidermis of the leaf the spores (*æcidiospores*) are liberated. These are formed in closely packed columns with intervening collapsed sterile cells. They are globose, minutely warted, and when they germinate send out a germ tube which is able to infect other leaves.

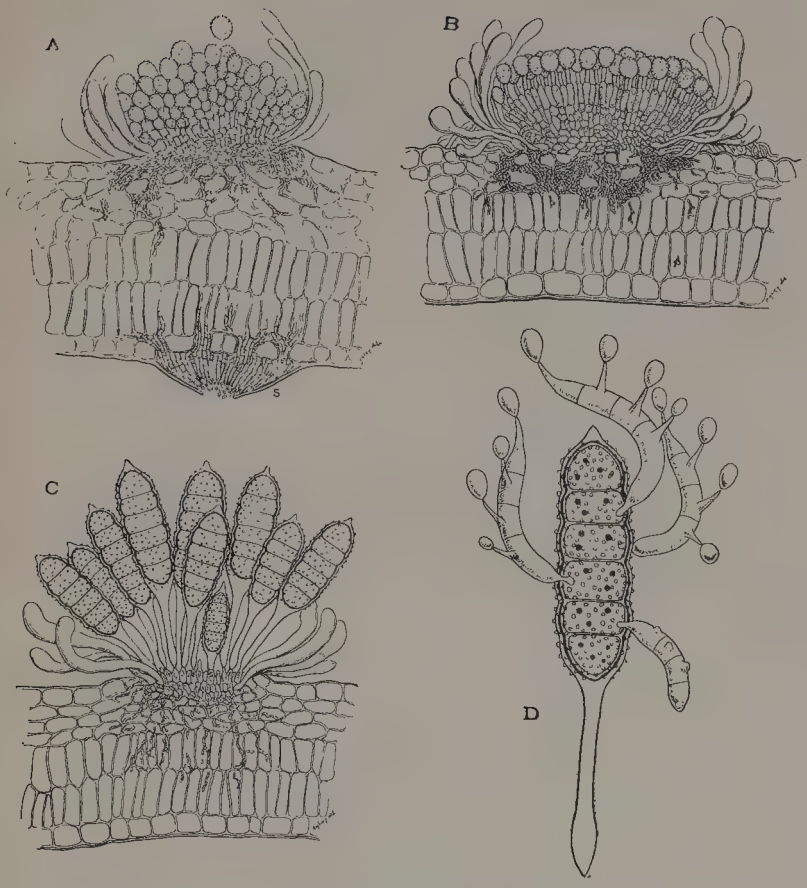
This spore form is also produced on the branches arising from a perennial mycelium under the bark. The patches of rust are generally much larger in this case, frequently being an inch or more in length, causing distortion or curving of the affected branches and often destroying the buds. It is recorded that as many as four different generations of æcidiospores may be produced in such spore beds. When the rust disappears from the cracks gaping wounds are left which are in such a condition that they are very liable to be infected by other fungi.

Minute structures may be seen on the upper surface of the leaf accompanying the cæoma. These are the so-called *spermogonia* (A.S.) which are usually broadly flask-shaped and contain minute spores, the *spermatia*. It is thought that these were originally

the male organs of the plant, fertilisation taking place to form the mother cell from which the æcidiospore arises. However this may be, the spermatia apparently play no part in the present life-cycle, not being capable of causing any infection of the host.

About June another spore form appears. This is the *uredospore*. The uredospore is also bright orange in colour and differs in external appearance from the æcidiospore only by being slightly echinulate and in having numerous germ pores. The spore bed (*sorus*) contains the spores on stalks ; the spores are borne singly, not in chains (B). They germinate by putting out a germ-tube which is able to infect new areas. The mycelium in this case is strictly localised. Both æcidiospore and uredospore are able to germinate immediately and rapidly propagate the parasite. It should be remarked, however, that it is not uncommonly held that the æcidiospore is the main source of new infection.

About August a change of colour occurs in the uredosorus. Formerly a bright orange it now becomes blackish. This is due to the fact that in place of the globose brightly coloured uredospores the underlying mycelium now produces much larger, elongated, oval bodies with thickened spore wall and with generally from five to eight cross walls (*c*). These are *teleutospores*, resting spores which are able to withstand the inclement conditions of winter and carry over the fungus to another growing season. They do not ger-



Phragmidium subcorticium Wint.: A, Section of cæoma showing æcidiospores in chains and spermogonia (S.). B. Section of uredosorus. C, Section of teleutosorus. D, Teleutospore germinating with production of septate promycelium and sporidia.

Magnification, 150.

minate immediately, germination taking place the following spring.

The germination of the teleutospore is quite different from that of the other spores (D). Each of the separate portions of the spore is able to put forth a " germ-tube " which becomes septate, each segment then producing a spore (*sporidium*). It is this production of a promycelium or basidium that shows the close relation of rust fungi with the Basidiomycetes, particularly with forms like the Jew's Ear. The sporidia are able to infect a new host plant and the mycelium there produced gives rise to the æcidiospores.

The life cycle of the fungus may be represented thus : æcidiospore — uredospore — teleutospore — sporidia—æcidiospore.

Other names for the fungus under consideration are : *Phragmidium subcorticatum** and *P. disciflorum* James. *Phragmidium* is a genus restricted to rosaceous plants. *P. fusiforme* occurs on *Rosa alpina.*

TREATMENT.

In experimental work it is usually very difficult to germinate the teleutospore and bring about infection. However, as the teleutospores are able to live through the winter, diseased leaves bearing them should be collected from the bushes and from the ground and burned.

* This is a *lapsus calami* for *subcorticium.*

As the mycelium is perennial in the branches all those portions showing infection should be cut out. Some growers sponge the patches of rust on the wood with a half-and-half solution of methylated spirit and water.

Where rust appeared the previous season or where infected wild Roses are present in the neighbourhood, spraying should be carried out just before the leaves begin to expand. Liver of sulphur has been found effective. Potassium permanganate solution (1-oz. in 5 pints of water with 2-oz. of soap added) is sometimes recommended. Probably Bordeaux mixture would also be effective.

CROWN GALL *(Bacterium tumefaciens* E.F.Sm. and Townsend.*)*

The galls or swellings on Rose stems which often occur at or near the ground level have been in the past attributed to various causes. It is now known that they are caused by a species of bacterium (*Bacterium tumefaciens*). Crown gall is a disease which has been recorded from all over the world occurring on a great variety of cultivated plants and on some wild ones.

In Roses the galls become quite hard and woody and more or less cracked or irregular at the surface when old. They vary greatly in size ; in

Manetti Rose stocks they may be more than 50 per cent. of the total weight. Though most frequent at the collar the galls may occur on any part of the root or shoot and are not at all uncommon on the branches. Most varieties of Roses are susceptible to tumour formation, but the character of the infection which follows depends upon whether the plant is growing rapidly or partially dormant. Well nourished rapidly growing plants produce much larger tumours than slowly growing ones.

The cells of the part of the Rose attacked are not disintegrated and killed, but are stimulated to rapid multiplication. The effect of the bacterial stimulus results in a growth resembling in every way the callus growths arising as a result of wounding.

By many the presence of galls is not regarded as being detrimental to a plant, but from the large size they frequently attain it is obvious that they must absorb material which has been elaborated by the plant for other purposes. Stunted growth is not, however, so common a result in Roses as in many other plants.

It was only after much research that the causal organism of crown gall was isolated. *Bacterium tumefaciens* is a small, white, motile, rod-shaped organism with polar flagellæ. It has not been possible to demonstrate the presence of the bacteria within the

cells of the gall by staining. Recent investigation has shown that in certain cases at least, the bacteria, which are first located on the wounded surface, and to some extent also in the vessels and adjoining intercellular spaces of the cortex, are later present as a film on the rough outer surface of the gall. Secondary galls are often produced, but these apparently are always due to the migration of the bacteria, which form new centres of pathological disturbance. By cross-inoculations it has been found that though there are differences in the virulence of different isolations there are only two or three well-marked strains.

Crown gall is very common on rosaceous plants and apparently the disease can be transferred from one species to another. Thus, for example, the bacteria from an apple tree can infect a Rose.

So far as we know infection of the host always takes place through wounds.

TREATMENT.

The only known treatment is to cut away the gall. The resulting wounded surface should be smeared with Stockholm tar to prevent a re-infection or the attack of fungi. *Coniothyrium Fuckelii* often occurs on broken down galls or on the wounds left after the gall's removal.

DOWNY MILDEW OR BLACK MILDEW *(Peronospora sparsa* Berk.*)*

Young Rose plants under glass frequently begin to wilt for no obvious reason and the leaves fall in showers when the branch is slightly shaken. On careful examination of the leaves irregular brown or brownish-purple spots are seen on the upper surface

Peronospora sparsa Berk. : Conidiophore bearing conidia. Magnification, 225.

and on the lower surface corresponding to these are small whitish-grey powdery fungal tufts. These are the conidiophores of *Peronospora sparsa,* one of the Phycomycetes. The spores (conidia) are comparatively large and serve for the rapid dissemina-

tion of the fungus. Owing to the extension of the fungal hyphæ in the tissues the brown spots extend rapidly and the leaves shrivel up and soon fall. The sepals may also be attacked. The fungus spreads to the stem first forming there elongated, sunken, dark brown patches. The whole plant eventually droops and dies. The disease so far has not been recorded out of doors in this country. Occasionally it arises in an epidemic form and causes considerable loss. When it infects a house its spread is remarkably rapid and destructive.

The resting spores (oospores) of the fungus have been recorded from the Continent. They are somewhat larger than the conidia and unlike them possess a thick, stratified and folded brown wall.

TREATMENT.

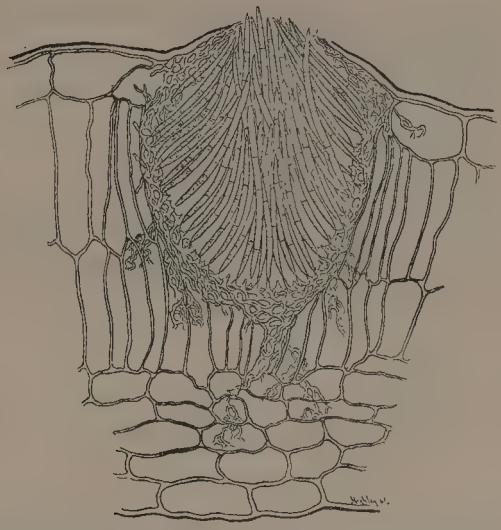
All dead and infected material should be removed and burned. Spraying with Bordeaux mixture or with liver of sulphur and opening up the ventilation has been successful in controlling the disease in some cases. Vaporising with sulphur is another method which has been recommended.

LEAF SCORCH (*Septoria Rosæ* Desm.).

The disease caused by *Septoria Rosæ* is not very common in an epidemic form, though the fungus is not rare on old leaves in areas which have been pre-

ROSE LEAF SCORCH.

viously attacked by rust. At times, however, it causes serious damage, more especially to nursery stock. In an epidemic form the fungus causes premature defoliation, affected plants being often quite leafless by the end of July. In a favourable season a second crop of leaves is produced with consequent various ill-effects. Roses attacked two seasons in succession rarely recover.



Septoria Rosæ Desm. : Section of Pycnidium. Magnification, 300.

The disease is confined to the leaves and first appears as minute yellowish green patches scattered over the surface. The patches become yellowish, increase in size, change gradually to a pale brown colour and are usually bordered by a dark reddish or purplish line. When young leaves are attacked the brown patches generally fall out and give the leaf a

" shot-hole " appearance. Towards autumn whitish spots appear here and there on the upper surface of the brown patches. These are the spores of the fungus which are extruded as tendril-like masses from the mouths of the fruit-bodies, which can be seen with the aid of a lens as minute black specks scattered over the surface. The fruit-body of the fungus is a more or less rounded structure sunk in the tissues of the leaf and occupying practically its whole thickness. It has no strongly marked wall. From the inner part of the hyphal weft which encloses it, narrow conidiophores arise which bear numerous thread-like, septate conidia, somewhat narrower at the ends ; these fill the cavity of the structure. The spores hang together for a time after they are extruded from the short neck of the fruit which just penetrates the leaf epidermis. These spore masses break up on drying and are scattered by wind and other agencies. Alighting on a leaf they are able to cause infection.

In addition to the above pycnidial stage a perfect or ascospore stage has recently been described from the Continent. It is a Pyrenomycete and has been given the name *Sphærulina Rehmiana* Jaap. It appears as groups of black dots usually on the upper surface of the leaf. Microscopical examination shows that the dots are the short stout necks of sunken spherical perithecia which have thick walls and contain numerous asci with eight thread-like, mostly three-septate spores. This form enables the fungus to sur-

vive the rigours of winter. The ascospores ripen in spring and bring about infection of young Rose leaves.

Septoria Rosæ-arvenis Sacc. and *Septoria Rosarum* Westend. appear to be forms of the fungus discussed above.

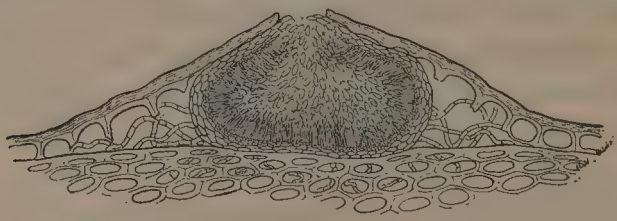
TREATMENT.

All diseased leaves, whether on the ground or remaining on the plant, should be gathered and burned. To get rid of infection from the bits of diseased leaves remaining on or in the soil the ground surrounding diseased plants should be drenched with a solution of copper sulphate or Cheshunt compound. In the spring, as the leaves open, spraying with liver of sulphur is reputed to be efficacious.

STEM CANKER (*Coniothyrium Fuckelii* Sacc.)

The subject of canker in Roses has proved somewhat of a stumbling block because of the various causes to which it has been attributed. It is now customary to regard the fungus *Coniothyrium* as the causal agent, but even when this suggestion was first made the lesions were confused with those of Crown Gall. Many have attributed the primary trouble to frost injury and regarded the fungus as a saprophyte living on the dead wound tissue. However, it has been shown experimentally that the spores or mycelium of *Coniothyrium Fuckelii* inoculated into healthy Roses, brambles or apples, either twigs or fruit, are able to produce the characteristic cankers.

The disease starts on the one-year-old wood and does not affect the leaves. It first shows as reddish or purplish spots which extend and become somewhat sunken and brown with a raised blackish border. Scattered over the surface may be seen numerous slight elevations of the epidermis which eventually cracks and discloses the minute blackish fruit-bodies of the fungus which are readily seen with a lens. The discolouration frequently extends all round the branch for several inches, usually being separated from the healthy tissue by a reddish border.



Coniothyrium Fuckelii Sacc. : Section of Pycnidium. Magnification, 225.

Often the disease progresses no further. Cracks, however, may develop on the infected portion. These cracks are often attributed to the action of frost. When once they are formed the plant produces a wound callus which in its turn is attacked by the mycelium of the fungus present in the stem tissues and there results the large, rugged, irregular canker, on which the fungus produces abundant fruit-bodies. These are flask-shaped with a well-marked dark brown wall and an apical opening. From the inner layer of the wall special hyphæ arise which form small brown elliptical

spores at their summits. The perfect stage of the fungus, *Leptosphæria Coniothyrium* Sacc., has a similar structure to that of the pycnidial stage, but encloses asci with eight, three-septate, fuscous spores. This Pyrenomycetous fungus is frequent on raspberry and blackberry stems, but so far has not been recorded from Roses.

The *Coniothyrium* on Roses is sometimes regarded as a distinct species, *C. Wernsdorffiæ* Laub.

ROSE GRAFT DISEASE (*Coniothyrium Rosarum* Cocke and Harkness.)

A serious disease of Roses which attacks the plants immediately after grafting, during the period in which they are kept in a warm moist atmosphere for the hastening of callus formation, has been described in America. The fungus causing the disease is very similar to that of Stem Canker. The characteristic symptom is the occurrence of lesions on the scion at, or just above, the union, which results in the sudden wilting and death of the young Rose graft. These lesions appear first as water-soaked areas, light yellow in colour, but as the tissues are killed they become dark brown. As the sub-epidermal tissues die the epidermis becomes loosened and changes colour from dark to light brown. The pycnidia of the fungus develop on the light brown areas, fruiting there a comparatively short time after

the death of the tissue and producing an abundance of spores. The leaves of the young shoots wilt and drop.

The lesions usually encircle the scion within a few days, so that the death of the graft is sudden. In some cases, however, the lesion extends up the stem as a narrow furrow; the graft does not die but gives rise to a dwarfed one-sided plant which may live for several years, developing cankers, which may include one half or more of the stem, and which serve as a constant source of infection. In plants two or three years old infection of the open wounds left by pruning or by cutting flowers may occur. The fungus grows down the stem on all sides, but rarely spreads more than three or four inches.

TREATMENT.

The method of overcoming the disease appears to be by the growth of resistant varieties, as the Manetti root stock is apparently quite immune to the disease.

DIE-BACK (*Gnomonia Rubi* Rehm.)

An extensive die-back of Rambler Roses due to the fungus *Gnomonia Rubi* has been described recently. So far it is reported only from the Royal Horticultural Society's Gardens at Wisley, but the fungus has been recorded as causing a disease of loganberry (Wye), and has been found on bramble at Keswick. The writer has seen it on loganberry at Richmond, Surrey.

The Ramblers affected were American Pillar, Lady Gray and Minnehaha. Long shoots (five to six feet) were dead and black, and leaves of others were yellowing and falling. Here and there ashen grey areas, several inches long, occurred, usually between the black portions and the healthy green tissues, the grey areas being separated from the green by a vivid reddish purple area, which, though diseased, was still living. The grey areas invariably bore remains of one or more dead buds, and the epidermis was cracked in several places. The die-back spread slowly until the shoots were killed down to the ground level.

Numerous papillæ developed on the grey areas, and later grew out as hair-like projections. These are the necks of small flask-like structures (perithecia), which contain septate spores in asci. The spores are not invariably eight in number, as is usual in Ascomycetes, but vary from five to eight, six being most frequent, with four larger than the remainder.

Inoculations with the fungus from the bramble showed that it was able to bring about infection and subsequent die-back in Rambler Roses and wild Roses. The spores are liberated at the time when the buds are beginning to open, and it is probable that infection takes place through the dead tissue of buds killed by frost.

TREATMENT.

The disease would apparently be controlled by cutting out the diseased branches and spraying in autumn with strong Bordeaux mixture and in early spring with ammoniacal copper carbonate.

GNOMONIA ROSÆ Fuckel.

Another Rose disease due to a species of *Gnomonia* has been recorded from the Continent. During the summer faded olive brown patches appear on the borders of leaves and gradually spread, but usually the leaf falls before the whole surface is covered. When one of the spots on the leaf is sectioned and examined under the microscope no spores are to be seen, although mycelium is massed in the upper epidermal cells and in the walls ; it is usually confined to the inter-cellular spaces in the palisade tissue and mesophyll of the leaf. In spite of the heavy infection the leaf tissues appear to be little altered.

About two months or so after the fall of the leaf, hair-like emergences may be seen somewhat regularly dispersed over its upper surface. These are the protruding necks of the fruit bodies (perithecia) of the fungus, which are buried in the tissues of the leaf occupying practically its whole cross section and often causing it to bulge on each surface. The perithecium has a well developed wall, and massed within its cavity are numerous asci containing eight spindle-shaped, colourless spores with a wall across the middle where they are sometimes slightly constricted.

TREATMENT.

The disease has not been recorded in an epidemic form. The burning of diseased leaves and a spraying of the bush in late spring with ammoniacal copper carbonate would doubtless keep the fungus in check.

BROWN CANKER *(Diaporthe umbrina* Jenkins.*)*

This disease appears to be widely spread in America. The canker may occur on any portion of the stem or branches, and may infect the petals.

The diseased areas on the stem first appear as raw-umber coloured patches sometimes surrounded by a purple border, though the margin of the canker is generally defined only by the difference in colour between the normal and cankered portions. The lesions differ from those of the common canker (*Coniothyrium Fuckelii*) in colour and appearance apparently never being depressed with raised margins ; moreover, the fruit of *Coniothyrium* appears darker. Scattered over the surface of the lesions may be seen the projecting necks of a fungus. This is a Pyrenonycete with a perfect stage containing asci (*Diaporthe*) and a pycnidial stage having two kinds of spores (*Phomopsis*).

The flowers are not infrequently attacked by the pycnidial stage with a resulting conspicuous discoloration.

The disease apparently sometimes gains entrance into the tissue through wounds caused by hail-storms, but at other times no trace of external injury can be seen. Whenever the fungus is established it advances rapidly producing the characteristic lesions. It is probable that the ascospores live over the winter in the old canker and produce early spring infection.

The so-called continuous blooming varieties are particularly susceptible.

TREATMENT.

Cankered stems should be cut away and burned. To protect plants from infection in spring it is suggested that strong Bordeaux mixture should be applied in autumn after the plants have become dormant and again in early spring. Later in the season ammoniacal copper carbonate may be substituted for Bordeaux mixture.

CROWN CANKER *(Cylindrocladium scoparium* Morgan.*)*

A disease which has been given the name Crown Canker* has been described as causing loss in flower production under glass in America. Plants are usually attacked at, or just above, the union of scion

* The name Crown Canker, although descriptive, is not perhaps the best that ould have been chosen as it is liable to be confused with that of stem canker and crown gall—two diseases, moreover, which have often been confused both in name and in symptoms.

and stock, the lesion frequently encircling the stem and advancing from ground level to several inches above the soil. The roots are also affected, sometimes the whole root system being involved. The first indication of the disease is a slight discolouration of the bark. As the disease advances the colour rapidly deepens to black, and the tissue appears as if soaked with water. The irregular lesions have at first a somewhat sharply defined margin, but as they increase in size the transition between healthy and diseased portions is not so well marked. Cracks soon appear in the bark and extend into the wood. At a later stage a swelling occurs at, and above, the affected area, the cracks meanwhile becoming deeper and more evident. Old lesions lose their black, water-soaked appearance. The powdery consistency of the diseased tissue, especially that underground, is very noticeable. Most suckers developing from the root of diseased plants are yellow and straggly, being affected at the point of attachment to the main stem.

The fungus is a weak parasite, and affected plants do not succumb but linger on with a gradually diminishing yield of blossoms. It is practically impossible to force such plants with fertilisers. Infected plants frequently have light green leaves. Moisture plays an important part in determining the degree of severity of the attack. Both grafted plants and those growing on their own roots are affected, and no variety appears to be immune. The casual organism is a Hyphomycete,

Cylindrocladium scoparium, which has elongated septate spores borne at the ends of conidiophores.

TREATMENT.

The spread of the disease is apparently lessened by having graft unions above the soil. Soil sterilisation and the use of healthy stock and scions for grafting is the only feasible method of controlling the disease.

ROESLERIA HYPOGÆA Thum. and Pass.

This fungus is chiefly known on account of its association with a root rot of grapes, but has been recorded from a large number of host plants, including Roses. The fruits of the fungus occur throughout the year, but particularly in autumn. They appear usually in clusters, each consisting of a straight or flexuous, white or greenish-yellow stalk, with a more or less globose, whitish, then greyish or greenish, villose head, the whole being somewhat less than a quarter of an inch high. The head is composed of a number of asci, interspersed with projecting paraphyses, which give it a villose appearance. The ascospores are hyaline and sperical, though occasional ones are flattened and slightly disc-shaped. There has been considerable difference of opinion as to whether or not *Roesleria* is parasitic. The most recent investigations show that when the ascospores are sown in wounds the fungus can establish itself in the tissues of living roots. The mycelium which develops is felty in appearance

and light to dull green in colour. The fruit-body is apparently produced only on dead roots.

SOOTY MOULD *(Fumago sp.)*

Roses do not suffer so frequently from Sooty Mould as do many other wild and cultivated plants. At times, however, the leaves show the characteristic appearance —a black sooty layer which peels off in flakes during hot weather. The whole of the upper surface of the leaf may be covered. The black substance is formed of a dense intermingled mass of dark coloured mycelia of several fungi, the most usual genus being *Fumago*— one of the Hyphomycetes. The fungal hyphæ in no way penetrate into the leaf tissues and consequently derive no nourishment from the plant, but subsist upon the " honey dew " deposited by Aphides. It is apparent, therefore, that leaves are disfigured in this way only when green-fly is present ; if these are kept in check Sooty Mould does not appear.

MISTLETOE *(Viscum album L.* var. *Mali* Tubeuf*)*

Recent research on the mistletoe has shown that in Europe this interesting species of flowering plant comprises three races or varieties. One of these, *Viscum album* var. *Mali,* occurs on broad-leaved plants, principally willow, poplar, beech and hazel, but occurs occasionally on other plants, including many rosaceous genera, amongst which is the Rose.

CHLOROSIS.

Many plant diseases were at one time regarded as physiological diseases, owing to no causal agent being known. Most of these have now been shown to be due to some infectious virus, which may be ultramicroscopic, and which may pass through a filter.

One of the few diseases which appears to be entirely due to a disturbance of the physiology of the plant and in no way attributable to a pathogenic organism is that known as *chlorosis*. The disease occasionally occurs in Roses, its symptoms being that the leaves gradually lose their green colour and become a sickly yellow. Usually it appears towards the end of spring, beginning frequently between the veins and along the borders of the younger leaves; the stem also shows yellow patches, which become confluent. Generally the whole of the leaf becomes yellow, but occasionally some parts remain green, and a speckled appearance results. The leaves shrivel and fall, and the plant produces weedy shoots and a crop of stunted leaves before it finally collapses. Owing to the loss of the green colouring matter the leaves are unable to perform their function of building up food material. With the cessation of carbon assimilation the plant starves to death; no flowering plant wholly without chlorophyll can continue to live—leaving out of account those bizarre plants which have taken to parasitic and saprophyric habits.

PLATE XI.

CHLOROSIS.

The term chlorosis is restricted to those abnormal plants of which the most conspicuous symptom is a deficiency in chlorophyll. Albino seedlings are excluded as they are definitely pathogenic. The inherited tendency to produce leaves or parts of leaves lacking chlorophyll, which is seen in healthy plants of many horticultural varieties, is not usually regarded as pathological, and is best spoken of as variegation. Such plants have sufficient green leaf surface to supply their needs.

Chlorosis is of two or three types; that affecting Roses is the common type, sometimes known as lime chlorosis. This type occurs in many plants, and has caused much concern to the French vine-growing industry owing to its prevalence on American vine stocks in certain districts.

It is common knowledge that a number of plants (calcifuges) are rarely found on calcareous soil. Roses, and several other plants, show the symptoms of chlorosis only when growing on calcareous soils—and the addition of carbonate of lime to the soil producing a normal plant will induce chlorosis. It is known from experiment that the presence of iron in an available form in the soil is necessary for the formation of chlorophyll. Moreover, the disease can be cured by treatment with iron. Consequently the unsuitability of calcareous soils for Roses and certain

other plants is presumably not due directly to the calcium carbonate present but simply to a depression in the availability of iron in calcareous soils.

TREATMENT.

Sulphate of iron in most cases arrests chlorosis in Roses if added to the soil at the rate of an ounce for each plant. It is best applied as crystals about the size of a pea, and should be lightly pricked in. Spraying the plant with a solution of an ounce of iron sulphate in six gallons of water often turns the leaves green. It is a good plan to combine the two methods until the symptoms disappear. In the case of pears and vines the insertion of iron sulphate powder mixed with half its weight of olive oil into a hole bored in the trunk has given good results.

BRONZING.

The leaves of certain varieties of Roses, especially those of young plants forced under glass, often show bronze mottled patches with a yellow border. The leaves so affected drop off, and the plant is consequently more or less starved, as well as being unattractive in appearance. Bronzing generally appears on new branches below where blooms have been removed. The main cause of the trouble appears to be over-feeding.

It does not seem advisable in a semi-popular account of Rose diseases, such as the above, to give detailed references to the original sources of information : such I would willingly supply, however, to anyone desiring to go more deeply into various matters. While not wishing to be inundated with queries I should be pleased to give my opinion and advice on diseased material sent in to me in a condition suitable for investigation. I would especially welcome specimens of rarer diseases.

SPRAYING APPLIANCES.

There are several types of Sprayers on the market, all more or less good in their way. The Publications Committee especially recommend :—

Syringe Type.

Cooper's Spray Diffuser, made by William Cooper and Nephews, Ltd., Berkhamsted, Herts.

The Abol Syringe, made by Abol, Ltd., Paddock Wood, Kent.

Pneumatic Type.

The Holder-Harriden, made by Holder-Harriden, Ltd., 1-2, Chiswell Street, E.C.

Knapsack Type.

The Four Oaks, made by The Four Oaks Company, Four Oaks, Sutton Coldfield.

KO-238-105